

(iii) Field Crops (Peanuts, Cotton, Sorghum, Soybeans, Sunflowers & Tobacco)

Chlorpyrifos may be applied to many field crops. Most crops in this category include: peanuts, cotton, tobacco, sorghum, soybeans and sunflowers. Peanuts and cotton are major chlorpyrifos use sites.

Peanut Uses: About 1.5 percent of total chlorpyrifos poundage is used on peanuts and is applied to about 10 percent (15 percent is likely maximum) of the approximately 1,600,000 acres of peanuts in the U.S.. Chlorpyrifos use on peanuts is mostly granular treatments and some minor spray applications. According to BEAD, the typical use rate on peanuts is 1.1 granular applications at an average of 1.8 lbs ai/A on approximately 160,000 to 240,000 acres. The leading states using chlorpyrifos in decreasing order of poundage are Georgia, North Carolina, Virginia and Alabama.

Wildlife utilization of peanut fields is relatively high with a fair diversity of avian and mammalian species. Wildlife reported to feed moderately to high in peanuts fields include quail, doves, songbirds, waterfowl, wild turkey, rabbits, squirrels, raccoons, opossum, and deer with a moderate to high degree of use. While it is unlikely that deer might be adversely affected, because of their large size, many of the other species could be affected by consumption of food items (such as seeds, insects and vegetation) found in chlorpyrifos-treated cotton fields. Bobwhite quail is the only species specifically listed as nesting in peanut fields.

Peanut Spray Uses: Directions for use on registered labels allow chlorpyrifos use on peanuts as a ground spray, pre-plant at 2 lbs ai/A and soil incorporated 3 to 4 inches. Soil incorporation after a spray application, reduces the amount of treated vegetation or insects on the soil surface, but it does not alter the concentration of the pesticide on the food items. Maximum seasonal application is 4 lbs ai/A for all uses. The following table shows the risk quotients fish and wildlife for sprayed peanut fields.

Risk Quotients for Peanuts (Pre-plant Spray; 1 Application at 2 lbs ai/A; 4-inch Soil Incorporation) (Terrestrial EEC's Based on Nomograph; Aquatic EEC's Based on GENEEC Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	30 - 480 ppm	102 ppm 147 ppm 647 ppm	0.29 - 4.7 0.20 - 3.3 0.046- 0.74
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	30 - 270 ppm	102 ppm 147 ppm 647 ppm	0.29 - 2.6 0.20 - 1.8 0.046- 0.42
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	30 ppm	462 ppm 647 ppm 3233 ppm	0.065 0.046 0.0093
Mammalian Subacute Dietary LC ₅₀	30 - 480 ppm	1330 ppm	0.023- 0.36

Mammalian Reproduction NOAEL	30 - 480 ppm	10 ppm	3 - 48
Avian Subacute Dietary LC ₅₀	30 - 480 ppm	136 ppm	0.22 - 3.5
Avian Reproduction NOAEL	30 - 480 ppm	25 ppm	1.2 - 19
Freshwater Fish Acute LC ₅₀	2.44 ppb	1.8 ppb	1.4
Fish Reproduction NOAEC	1.23 - 2.17 ppb	0.57 ppb	2.2 - 3.8
Aquatic Invertebrate Acute LC ₅₀	2.44 ppb	0.10 ppb	24
Freshwater Invert. Reproduction NOAEC	1.23 - 2.17 ppb	0.04 ppb	31 - 54
Estuarine Fish Acute LC ₅₀	2.44 ppb	0.96 ppb	2.5
Estuarine Fish Reproduction NOAEC	1.23 - 2.17 ppb	0.28 ppb	4.4 - 7.8
Estuarine Invertebrate Acute LC ₅₀	2.44 ppb	0.035 ppb	70
Estuarine Invert. Reproduction NOAEC	1.23 - 2.17 ppb	< 0.0046 ppb	> 270 > 470

Risk Summary for Maximum Peanut Spray Uses: A pre-plant spray treatment of chlorpyrifos to peanuts yields risk quotients which exceed the levels of concern for most non-target aquatic and terrestrial animals. Risk quotients for the spray use are mammalian acute (0.009-4.7), subacute dietary (0.023-0.36) and reproduction NOAEL (3-48); avian dietary (0.22-3.5) and reproduction NOAEL (1.2-19), freshwater fish acute (1.4) and reproduction NOAEC (2.2-3.8), aquatic invertebrate acute (24) and reproduction NOAEC (31-54), estuarine fish acute (2.5) and reproduction NOAEC (4.4-7.8), estuarine invertebrate acute (70) and reproduction NOAEC (>270->470).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 4.8 ppm and whole fish of 3.3 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm and less than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and less than the avian reproductive NOAEL of 25 ppm.

Peanut Granular Uses: Directions for use on registered labels allow chlorpyrifos use on peanuts as a granular application in a 6 to 12-inch band, as a ground application with soil incorporation at planting at 1.13-2.25 oz. ai/1000 ft and applied again at postplant, if applied earlier at 1.13 oz. ai/1000 ft. Granules are banded at early pegging at 2.25 oz. ai/1000 ft or applied as an aerial broadcast prior to or at pegging at 1.95 lb ai/A. The time interval between the two applications is not specified on the label, hence the typical period of 40 days used in Georgia is used. Since the first application is soil incorporated, separate risk scenarios are used for the terrestrial and aquatic habitats. Accumulation of granules from the first application following the second treatment is considered minor and has been ignored. The terrestrial EECs for wildlife are higher occurs from the early peg, granular application. Aquatic areas get input from both applications. Maximum seasonal application is 4 lbs ai/A for all uses. The following tables show the risk quotients for granular uses on peanuts and the additive risks from the pre-plant spray and post-plant granular applications.

Granular Risk Quotients for Peanuts (6-Inch Band at Plant, 1 Application at 2.25 oz. ai/1000 ft; 4-inch Soil Incorporation) (Terrestrial EEC's Based on Formula*; Aquatic EEC's Based on GENEEC Model**)				
Species	Toxicity	Exposure	Toxicity Dose	Risk Quotient
Mammalian LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	97 mg/kg	19 mg/ft ² *	1.5 mg 3.4 mg 97 mg	13 5.6 0.20
Avian Acute Oral LD ₅₀ (27.7 grams body wt.)	10 mg/kg	19 mg/ft ² *	0.28 mg	68
Freshwater Fish Acute LC ₅₀	1.8 ppb	2.49 ppb		1.4
Fish Reproduction NOAEC	0.57 ppb	1.26- 2.17 ppb		2.2 - 3.8
Aquatic Invertebrate Acute LC ₅₀	0.10 ppb	2.49 ppb		25
Freshwater Invert. Reproduction NOAEC	0.04 ppb	1.26- 2.17 ppb		32 - 54
Estuarine Fish Acute LC ₅₀	0.96 ppb	2.49 ppb		2.6
Estuarine Fish Reproduction NOAEC	0.28 ppb	1.26- 2.17 ppb		4.5 - 7.8
Estuarine Invertebrate Acute LC ₅₀	0.035 ppb	2.49 ppb		71
Estuarine Invert. Reproduction NOAEC	< 0.0046 ppb	1.26- 2.17 ppb		>270 > 470

* mg ai/ft² = $\frac{(2.25 \text{ oz ai/1000 ft row}) \times 28,349 \text{ mg/oz.} \times 15 \% \text{ exposed}}{1,000 \text{ feet row} \times \text{band width (0.5 ft.)}}$ = 19 mg ai./ft.²

** lbs ai/A = $\frac{2.25 \text{ (oz. ai./1000 feet of row)} \times 43560 \text{ ft}^2/\text{A}}{16 \text{ oz./lb} \times 1000 \text{ ft} \times 2.0 \text{ row spacing (ft.)}}$ = 3 lbs/A

Risk Summary for Maximum At-Plant Peanut Granular Uses: An at-plant granular application of chlorpyrifos to peanuts yields risk quotients which exceed the levels of concern for all non-target aquatic and terrestrial animal groupings. Risk quotients for the at-plant granular use are mammalian acute (0.20-13), avian acute (68), freshwater fish acute (1.4) and reproduction NOAEC (2.2-3.8), aquatic invertebrate acute (25) and reproduction NOAEC (32-54), estuarine fish acute (2.6) and reproduction NOAEC (4.5-7.8), estuarine invertebrate acute (71) and reproduction NOAEC (>270->470).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 4.9 ppm and whole fish of 3.4 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm and less than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and less than the avian reproductive NOAEL of 25 ppm.

Granular Risk Quotients for Peanuts (Aerial Broadcast prior to or at Early Pegging, 1 Application at 1.95 lbs ai/A) (Terrestrial EEC's Based on Formula*; Aquatic EEC's Based on GENEEC Model)				
Species	Toxicity	Exposure	Toxicity Dose	Risk Quotient

Mammalian LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	97 mg/kg	20 mg/ft ² *	1.5 mg 3.4 mg 97 mg	13 5.9 0.21
Avian Acute Oral LD ₅₀ (27.7 grams body wt.)	10 mg/kg	20 mg/ft ² *	0.28 mg	71
Freshwater Fish Acute LC ₅₀	1.8 ppb	1.66 ppb		0.92
Fish Reproduction NOAEC	0.57 ppb	0.84-1.45 ppb		1.5 - 2.5
Aquatic Invertebrate Acute LC ₅₀	0.10 ppb	1.66 ppb		17
Freshwater Invert. Reproduction NOAEC	0.04 ppb	0.84-1.45 ppb		21 - 36
Estuarine Fish Acute LC ₅₀	0.96 ppb	1.66 ppb		1.7
Estuarine Fish Reproduction NOAEC	0.28 ppb	0.84-1.45 ppb		3 - 5.1
Estuarine Invertebrate Acute LC ₅₀	0.035 ppb	1.66 ppb		47
Estuarine Invert. Reproduction NOAEC	< 0.0046 ppb	0.84-1.45 ppb		> 180 > 320

$$* \text{ mg ai/foot}^2 = \frac{1.95 \text{ lb ai/A} \times 453,590 \text{ mg/lb}}{43,560 \text{ ft}^2} = 20 \text{ mg/ft}^2$$

Risk Summary for Maximum Broadcast Peanut Granular Uses at Early Pegging: A broadcast granular application of chlorpyrifos to peanuts at early pegging yields risk quotients which exceed the levels of concern for all non-target aquatic and terrestrial animal groupings. Risk quotients for the at-plant granular use are mammalian acute (0.21-13), avian acute (71), freshwater fish acute (0.92) and reproduction NOAEC (1.5-2.5), aquatic invertebrate acute (17) and reproduction NOAEC (21-36), estuarine fish acute (1.7) and reproduction NOAEC (3.0-5.1), estuarine invertebrate acute (47) and reproduction NOAEC (>180->320).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 3.3 ppm and whole fish of 2.3 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm and less than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and less than the avian reproductive NOAEL of 25 ppm.

Combined Risks for Multiple Peanut Uses: Combined risks for multiple applications for spray and granular applications should be assessed to determine the full extent of exposures for non-target aquatic and terrestrial animals. However at present, no methodology exists to combine terrestrial risk assessments for spray and granular applications (i.e., EECs expressed in ppm or ppb can not be added to mg/sq² foot). Consequently, only aquatic risks are assessed for the combination of the two peanut applications (pre-plant and at-pegging). Aquatic EECs were modelled using the PRZM3.12-EXAMS model on Tifton loamy sand soil in Crisp Co., Georgia and local rainfall conditions. Risk Quotients are summarized in the table below.

Aquatic Risk Quotients for Peanuts in Crisp Co., Ga
(Pre-plant Spray (4" Soil Incorporation) and at Early Peg Granular Application (Aerial Broadcast); 2 Applications at 2 lbs ai/A
(Aquatic EEC's Based on PRZM3.12-EXAMS Model)

Species	Exposure	Toxicity	Risk Quotient
Freshwater Fish Acute LC ₅₀	9.38 ppb	1.8 ppb	5.2
Fish Reproduction NOAEC	4.29 - 7.36 ppb	0.57 ppb	7.5 - 13
Aquatic Invertebrate Acute LC ₅₀	9.38 ppb	0.10 ppb	94
Freshwater Invert. Reproduction NOAEC	4.29 - 7.36 ppb	0.04 ppb	110 - 180
Estuarine Fish Acute LC ₅₀	9.38 ppb	0.96 ppb	9.8
Estuarine Fish Reproduction NOAEC	4.29 - 7.36 ppb	0.28 ppb	15 - 26
Estuarine Invertebrate Acute LC ₅₀	9.38 ppb	0.035 ppb	270
Estuarine Invert. Reproduction NOAEC	4.29 - 7.36 ppb	< 0.0046 ppb	>930 > 1600

Risk Summary for Accumulation of Maximum Spray and Granular Peanut Uses:

Accumulation of residues in the aquatic environment from a pre-plant and an early pegging applications (maximum of 4 lbs ai/A per year) at a 40-day interval period yields risk quotients which exceed the levels of concern for all non-target aquatic groupings, except estuarine algae. Aquatic risk quotients for the two combined applications are as follows: freshwater fish acute (5.2) and reproduction NOAEC (7.5-13), aquatic invertebrate acute (94) and reproduction NOAEC (110-180), estuarine fish acute (9.8) and reproduction NOAEC (15-26), estuarine invertebrate acute (270) and reproduction NOAEC (>930 >1600).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 16 ppm and whole fish of 12 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and the avian reproductive NOAEL of 25 ppm.

Typical Peanut Use: According to a Dow response (1999) the typical application is a granular, band application at 2.25 oz. ai/1000 feet of row at the early pegging growth stage. In the table below, the risk quotients are assessed for a typical use scenario.

Granular Risk Quotients for Typical Use on Peanuts (6-Inch Band at Plant, 1 Application at 2.25 oz. ai/1000 ft; 4-inch Soil Incorporation) (Terrestrial EEC's Based on Formula*; Aquatic EEC's Based on GENEEC Model**)				
Species	Toxicity	Exposure	Toxicity Dose	Risk Quotient
Mammalian LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	97 mg/kg	19 mg/ft ² *	1.5 mg 3.4 mg 97 mg	13 5.6 0.20
Avian Acute Oral LD ₅₀ (27.7 grams body wt.)	10 mg/kg	19 mg/ft ² *	0.28 mg	68
Freshwater Fish Acute LC ₅₀	1.8 ppb	2.49 ppb		1.4
Fish Reproduction NOAEC	0.57 ppb	1.26- 2.17 ppb		2.2 - 3.8

Aquatic Invertebrate Acute LC ₅₀	0.10 ppb	2.49 ppb		25
Freshwater Invert. Reproduction NOAEC	0.04 ppb	1.26- 2.17 ppb		32 - 54
Estuarine Fish Acute LC ₅₀	0.96 ppb	2.49 ppb		2.6
Estuarine Fish Reproduction NOAEC	0.28 ppb	1.26- 2.17 ppb		4.5 - 7.8
Estuarine Invertebrate Acute LC ₅₀	0.035 ppb	2.49 ppb		71
Estuarine Invert. Reproduction NOAEC	< 0.0046 ppb	1.26- 2.17 ppb		>270 > 470

$$* \text{ mg ai/ft}^2 = \frac{(2.25 \text{ oz ai/1000 ft row}) \times 28,349 \text{ mg/oz.} \times 15 \% \text{ exposed}}{1,000 \text{ feet row} \times \text{band width (0.5 ft.)}} = 19 \text{ mg ai./ft.}^2$$

$$** \text{ lbs ai/A} = \frac{2.25 \text{ (oz. ai./1000 feet of row)} \times 43560 \text{ ft}^2/\text{A}}{16 \text{ oz./lb} \times 1000 \text{ ft} \times 2.0 \text{ row spacing (ft.)}} = 3 \text{ lbs/A}$$

Risk Summary for Typical Peanut Granular Use at the Early Pegging Stage: The typical application of chlorpyrifos on peanuts is a granular treatment at early pegging growth stage and yields risk quotients which exceed the levels of concern for all non-target aquatic and terrestrial animal groupings. Risk quotients for the pegging stage, granular use are mammalian acute (0.20-13), avian acute (68), freshwater fish acute (1.4) and reproduction NOAEC (2.2-3.8), aquatic invertebrate acute (25) and reproduction NOAEC (32-54), estuarine fish acute (2.6) and reproduction NOAEC (4.5-7.8), estuarine invertebrate acute (71) and reproduction NOAEC (>270->470).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 4.9 ppm and whole fish of 3.4 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm and less than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and less than the avian reproductive NOAEL of 25 ppm.

Cotton Uses: Chlorpyrifos use on cotton includes a seed slurry treatment, a gin trash treatment, and up to six foliar broadcast spray applications. Discussion of risks posed by seed treatments are addressed at the beginning of the corn section. The use rate on cotton seed is 2 oz. ai/ 100 lbs of seed which is twice the uses rate of corn and other seed treatments. Therefore the risks are twice that of corn seed and the number of seeds equivalent to the LD₅₀ is half the number for corn. Chlorpyrifos use on gin trash has not been assessed for eco-risks. The major chlorpyrifos use on cotton is six foliar spray applications per season. According to BEAD, about 3.2 percent of the total chlorpyrifos use is applied to about 5 percent (likely maximum of 6 percent) of the approximately 12,400,000 acres of cotton in the U.S. The typical average chlorpyrifos usage on cotton is 1.7 applications at 0.6 lbs ai/A on approximately 640,000 to 800,000 acres. The leading states using about 84 percent of the chlorpyrifos applied to cotton in decreasing order of poundage are Arizona, Mississippi, and California, Texas, and Louisiana.

Wildlife utilization of cotton fields is low to moderate. Wildlife that feed in cotton fields include quail, pheasant, doves, songbirds, rabbits, raccoon, and deer with a low to high degree of use. While it is unlikely that deer might be adversely affected, because of their large size, many of the

other species could be affected by consumption of food items (such as seeds, insects and vegetation) found in chlorpyrifos-treated cotton fields. Bobwhite quail, pheasant (brood-rearing), and rabbits also nest and brood young in cotton fields. The following tables estimate the risks quotients for chlorpyrifos applications on cotton.

The major chlorpyrifos use on cotton is six spray applications per season by ground, aerial or sprinkler irrigation equipment primarily as a broadcast foliar spray at 0.1875 to 1 lb ai/A depending on the pest in all states. Risks have been assessed for 6 aerial applications at the maximum use rate (1 lb ai/A), and BEAD's typical rate (1.7 aerial applications at 0.6 lbs ai/A). Dow's response (1999) holds that the 3-day retreatment interval is "an extremely low probability" and that the typical use is 1 spray application at 0.75 lbs ai/A. This maximum use rate assessment has not been changed to reflect the typical use rate cited in this comment.

Multiple Aerial Foliar Spray Applications on Cotton: Aquatic EECs were modelled by EFED on Loring silt loam and local rainfall conditions in Jackson, Mississippi, using the PRZM3.12-EXAMS model. Assessment of risks for six foliar applications at the maximum use rate (1 lb ai/A) on cotton are presented in the following table.

Risk Quotients for Cotton in Jackson Co., Mississippi (Postplant Foliar Spray; 1 lb ai/A; 6 Applications; 3-Day Interval) (Terrestrial EEC's Based on FATE Model; Aquatic EEC's Based on PRZM3.12-EXAMS Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	48.5- 777 ppm	102 ppm 147 ppm 647 ppm	0.48 - 7.6 0.33 - 5.3 0.075- 1.2
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	48.5- 437 ppm	102 ppm 147 ppm 647 ppm	0.48 - 4.3 0.33 - 3.0 0.075- 0.68
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	48.5 ppm	462 ppm 647 ppm 3233 ppm	0.10 0.075 0.015
Mammalian Subacute Dietary LC ₅₀	48.5- 777 ppm	1330 ppm	0.036- 0.58
Mammalian Reproduction NOAEL	48.5- 777 ppm	10 ppm	4.9 - 78
Avian Subacute Dietary LC ₅₀	48.5- 777 ppm	136 ppm	0.36- 5.7
Avian Reproduction NOAEL	48.5- 777 ppm	25 ppm	1.9 - 31
Freshwater Fish Acute LC ₅₀	27.2 ppb	1.8 ppb	15
Fish Reproduction NOAEC	17.3- 22.9 ppb	0.57 ppb	30 - 40
Aquatic Invertebrate Acute LC ₅₀	27.2 ppb	0.10 ppb	270
Freshwater Invert. Reproduction NOAEC	17.3- 22.9 ppb	0.04 ppb	430 - 570
Estuarine Fish Acute LC ₅₀	27.2 ppb	0.96 ppb	28
Estuarine Fish Reproduction NOAEC	17.3- 22.9 ppb	0.28 ppb	62 - 82

Estuarine Invertebrate Acute LC ₅₀	27.2 ppb	0.035 ppb	780
Estuarine Invert. Reproduction NOAEC	17.3- 22.9 ppb	< 0.0046 ppb	>3800 > 5000

Risk Summary for Maximum Use Rates and Six Applications on Cotton: The maximum chlorpyrifos use rate on cotton is six aerial, foliar spray treatments which yields risk quotients that exceed levels of concern for species in most non-target aquatic and terrestrial animals. Risk quotients for the six spray applications are mammalian acute (0.015-7.6), subacute dietary (0.036-0.58), and reproduction NOAEL (4.9-78), avian subacute dietary (0.36-5.7) and reproduction NOAEL (1.9-3.1), freshwater fish acute (15) and reproduction NOAEC (30-40), aquatic invertebrate acute (270) and reproduction NOAEC (340-570), estuarine fish acute (28) and reproduction NOAEC (62-82), estuarine invertebrate acute (780) and reproduction NOAEC (>3800->5000). Other geographically limited, cotton uses pose less risk, but the risk quotients still exceed levels of concern for non-target aquatic and terrestrial animals.

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 67 ppm and whole fish of 47 ppm. These levels are less than the mammalian subacute LC50 value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC50 value of 136 ppm but more than the avian reproductive NOAEL of 25 ppm.

Typical Cotton Use: According to BEAD, the typical average chlorpyrifos usage on cotton is 1.7 applications at about 0.6 lbs ai/A. In the table below, the risk quotients are assessed for a single typical application scenario. About 70 percent of the chlorpyrifos-treated cotton receives a second application which yields higher risk quotients than for the single application.

Risk Quotients for Typical Use on Cotton (Mississippi) (Post-emergent, Foliar Spray; 1 Application at 0.6 lbs ai/A) (Terrestrial EEC's Based on Nomograph; Aquatic EEC's Based on PRZM3-EXAMS Model)			
Surrogate Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	7.5 - 120 ppm	102 ppm 147 ppm 647 ppm	0.074 - 1.2 0.051 - 0.82 0.012 - 0.19
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	7.5 - 67.5 ppm	102 ppm 147 ppm 647 ppm	0.074 - 0.66 0.051 - 0.46 0.012 - 0.10
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	7.5 ppm	462 ppm 647 ppm 3233 ppm	0.016 0.012 0.002
Mammalian Subacute Dietary LC ₅₀	7.5 - 120 ppm	1330 ppm	0.007 - 0.09
Mammalian Reproduction NOAEL	7.5 - 120 ppm	10 ppm	0.75 - 12
Avian Subacute Dietary LC ₅₀	7.5 - 120 ppm	136 ppm	0.007 - 0.88
Avian Reproduction NOAEL	7.5 - 120 ppm	25 ppm	0.30 - 4.8

Freshwater Fish Acute LC ₅₀	1.4 ppb	1.8 ppb	0.77
Fish Reproduction NOAEC	0.6 - 1.1 ppb	0.57 ppb	1.1 - 1.9
Aquatic Invertebrate Acute LC ₅₀	1.4 ppb	0.10 ppb	14
Freshwater Invert. Reproduction NOAEC	0.6 - 1.1 ppb	0.04 ppb	15 - 28
Estuarine Fish Acute LC ₅₀	1.4 ppb	0.96 ppb	1.5
Estuarine Fish Reproduction NOAEC	0.6 - 1.1 ppb	0.28 ppb	2.1 - 3.9
Estuarine Invertebrate Acute LC ₅₀	1.4 ppb	0.035 ppb	40
Estuarine Invert. Reproduction NOAEC	0.6 - 1.1 ppb	< 0.0046 ppb	> 130 > 240

Risk Summary for the Typical Cotton Use: Risk quotients modelled for 1 spray application on Mississippi cotton at the typical use rate exceed the levels of concern for most non-target aquatic and terrestrial animals. The risk quotients for a typical application is as follows: mammalian acute (0.002-1.2) and reproduction NOAEL (0.75-12), avian acute (0.007-0.88) and reproduction NOAEL (0.30-4.8), freshwater fish acute (0.77) and reproduction NOAEC (1.1-1.9), freshwater invertebrates acute (14) and reproduction NOAEC (15-28), estuarine fish acute (1.5) and reproduction NOAEC (2.1-3.9), and estuarine invertebrates acute (40) and reproduction NOAEC (>130->240). Risks are higher for the 70 percent of the chlorpyrifos-treated cotton which typically receives a second application.

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 2.3 ppm and whole fish of 1.6 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm and less than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and less than the avian reproductive NOAEL of 25 ppm.

In about 70 percent of the cases, cotton is treated with a second application which yields RQs that are even higher than the above risk values.

Tobacco Uses: Chlorpyrifos use on tobacco represents less than 1 percent of the total poundage of chlorpyrifos. Chlorpyrifos is applied to about 11 percent (likely maximum of 14 percent treated) of the approximately 700,000 acres of tobacco in the U.S. According to BEAD, the typical chlorpyrifos usage on tobacco is 1 application at 2.0 lbs ai/A on approximately 73,000 to 96,000 acres. The leading states using 81 percent of the chlorpyrifos applied to tobacco are North Carolina, South Carolina, Virginia, and Georgia.

Wildlife utilization of tobacco is moderate. Wildlife that feed in tobacco fields include quail, doves, songbirds, rabbits and deer. While it is unlikely that deer might be adversely affected, because of their large size, the other species could be affected by consumption of food items (such as seeds, insects and vegetation) found in chlorpyrifos-treated tobacco fields. Bobwhite quail and rabbits brood young in tobacco fields.

Directions for tobacco use on registered labels are limited to chlorpyrifos applications as a single, pre-transplant, soil-incorporated treatment with ground equipment. The major chlorpyrifos formulation used on tobacco is a spray treatment. Granules are applied prior to transplant. Granular pre-transplant treatments with soil incorporation are applied at 2-3 lbs ai/A by ground equipment. The spray treatments at 5 lbs ai/A are limited to North Carolina, South Carolina, and Virginia. Chlorpyrifos is sprayed at 2 lbs ai/A in a tank mix use in all tobacco growing areas.

Aquatic EECs were modelled by EFED using the PRZM3.12-EXAMS model on Norfolk loamy sand soil in Wake Co., North Carolina and local rainfall conditions. The following table estimates the risk quotients for tobacco for maximum applications as a spray treatment.

Risk Quotients for Tobacco in Wake Co., North Carolina (Limited to NC, SC, and VA Only) (Pre-transplant Ground Spray, 1 Application at 5 lbs ai/A; 4-inch Soil Incorporation) (Terrestrial EECs Based on Nomograph, Aquatic EECs Based on PRZM3.12-EXAMS Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	680 -1200 ppm	102 ppm 147 ppm 647 ppm	6.7 - 12 4.6 - 8.2 1.1 - 1.9
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	75 - 680 ppm	102 ppm 147 ppm 647 ppm	0.74 - 6.6 0.51 - 4.6 0.12 - 1.1
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	75 ppm	462 ppm 647 ppm 3233 ppm	0.16 0.12 0.023
Mammalian Subacute Dietary LC ₅₀	75 -1200 ppm	1330 ppm	0.056- 0.90
Mammalian Reproduction NOAEL	75 -1200 ppm	10 ppm	7.5 -120
Avian Subacute Dietary LC ₅₀	75 -1200 ppm	136 ppm	0.55 - 8.8
Avian Reproduction NOAEL	75 -1200 ppm	25 ppm	3 - 48
Freshwater Fish Acute LC ₅₀	30.6 ppb	1.8 ppb	17
Fish Reproduction NOAEC	12.0 - 24.0 ppb	0.57 ppb	21 - 42
Aquatic Invertebrate Acute LC ₅₀	30.6 ppb	0.10 ppb	310
Freshwater Invert. Reproduction NOAEC	12.0 - 24.0 ppb	0.04 ppb	300 - 600
Estuarine Fish Acute LC ₅₀	30.6 ppb	0.96 ppb	32
Estuarine Fish Reproduction NOAEC	12.0 - 24.0 ppb	0.28 ppb	43 - 86
Estuarine Invertebrate Acute LC ₅₀	30.6 ppb	0.035 ppb	870
Estuarine Invertebrate NOAEC	12.0 - 24.0 ppb	< 0.0046 ppb	> 2600 >5200
Estuarine Algae EC ₅₀	30.6 ppb	140 ppb	0.21

Risk Summary for Maximum Tobacco Spray Use: One 5 lb ai/A ground spray treatment of chlorpyrifos to tobacco with soil incorporation yields risk quotients which exceed the levels of

concern for non-target aquatic and terrestrial animals. The ranges of risk quotients for a single, 5 lbs ai/A application are mammalian acute (0.023-12), mammalian subacute dietary (0.056-0.90), mammalian reproduction NOAEL (7.5-120), avian subacute dietary (0.55-8.8), avian reproduction NOAEL (3-48), fresh water fish acute (17) and reproduction NOAEC (21-42), aquatic invertebrate acute (310) and reproduction NOAEC (300-600), estuarine fish acute (32) and reproduction NOAEC (43-86), estuarine invertebrate acute (870) and reproduction NOAEC (>2600->5200), and estuarine algae (0.21).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 47 ppm and whole fish of 33 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm but more than the avian reproductive NOAEL of 25 ppm.

The following table estimates the risk quotients for tobacco for maximum applications as a granular treatment.

Granular Risk Quotients for Tobacco (Pre-transplant, 1 Application at 3.0 lb ai/A; Soil Incorporation, Assume 4-inch) (Terrestrial EEC's Based on Formula; Aquatic EEC's Based on GENEEC Model)				
Species	Toxicity	Exposure	Toxicity Dose	Risk Quotient
Mammalian LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	97 mg/kg	4.7 mg/ft ² *	1.5 mg 3.4 mg 97 mg	3.1 1.4 0.048
Avian Acute Oral LD ₅₀ (27.7 grams body wt.)	10 mg/kg	4.7 mg/ft ² *	0.28 mg	17
Freshwater Fish Acute LC ₅₀	1.8 ppb	10 ppb		5.6
Fish Reproduction NOAEC	0.57 ppb	4.9 - 8.6 ppb		8.6 - 15
Aquatic Invertebrate Acute LC ₅₀	0.10 ppb	10 ppb		100
Freshwater Invert. Reproduction NOAEC	0.04 ppb	4.9 - 8.6 ppb		120 - 220
Estuarine Fish Acute LC ₅₀	0.96 ppb	10 ppb		10
Estuarine Fish Reproduction NOAEC	0.28 ppb	4.9 - 8.6 ppb		18 - 31
Estuarine Invertebrate Acute LC ₅₀	0.035 ppb	10 ppb		280
Estuarine Invert. Reproduction NOAEC	< 0.0046 ppb	4.9 - 8.6 ppb		>1100 >1900
Estuarine Algae EC ₅₀	140 ppb	10 ppb		0.071

$$* \text{ mg ai/foot}^2 = \frac{3.0 \text{ lb ai/A} \times 453,590 \text{ mg/lb} \times 15\% \text{ exp.}}{43,560 \text{ ft}^2} = 4.7 \text{ mg/ft}^2$$

Risk Summary for Maximum Tobacco Granular Use: Granular treatment with chlorpyrifos to pre-transplanted tobacco yields risk quotients which exceed the levels of concern for non-target

aquatic and terrestrial animals. The risk quotients are mammalian acute (0.048-3.1), avian acute (17), fresh water fish acute (5.6) and reproduction NOAEC (8.6-15), aquatic invertebrate acute (100) and reproduction NOAEC (120-220), estuarine fish acute (10) and reproduction NOAEC (18-31), estuarine invertebrate acute (280) and reproduction NOAEC (>1100->1900) and estuarine algae (0.071).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 19 ppm and whole fish of 13 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and less than the avian reproductive NOAEL of 25 ppm.

Typical Tobacco Use: According to BEAD, the typical chlorpyrifos usage on tobacco is 1 application at about 2.0 lbs ai/A on approximately 76,000 to 97,000 acres. In the table below, the risk quotients are assessed for a typical, single application on tobacco at 2.0 lbs ai/A.

Risk Quotients for Typical Use on Tobacco (Pre-transplant, Ground Spray; 1 Application at 2.0 lbs ai/A; 4-inch Soil Incorporation) (Terrestrial EEC's Based on Nomograph; Aquatic EEC's Based on GENEEC Model)			
Surrogate Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	30 - 480 ppm	102 ppm 147 ppm 647 ppm	0.29 - 4.7 0.22 - 3.6 0.051 - 0.82
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	30 - 270 ppm	102 ppm 147 ppm 647 ppm	0.29 - 2.6 0.20 - 1.8 0.046 - 0.42
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	30 ppm	462 ppm 647 ppm 3233 ppm	0.065 0.046 0.009
Mammalian Subacute Dietary LC ₅₀	30 - 480 ppm	1330 ppm	0.022 - 0.36
Mammalian Reproduction NOAEL	30 - 480 ppm	10 ppm	3.0 - 48
Avian Subacute Dietary LC ₅₀	30 - 480 ppm	136 ppm	0.22 - 3.5
Avian Reproduction NOAEL	30 - 480 ppm	25 ppm	1.2 - 19
Freshwater Fish Acute LC ₅₀	2.66 ppb	1.8 ppb	1.5
Fish Reproduction NOAEC	1.25 - 2.34 ppb	0.57 ppb	2.2 - 4.1
Aquatic Invertebrate Acute LC ₅₀	2.66 ppb	0.10 ppb	27
Freshwater Invert. Reproduction NOAEC	1.25 - 2.34 ppb	0.04 ppb	31 - 59
Estuarine Fish Acute LC ₅₀	2.66 ppb	0.96 ppb	2.8
Estuarine Fish Reproduction NOAEC	1.25 - 2.34 ppb	0.28 ppb	4.5 - 8.4
Estuarine Invertebrate Acute LC ₅₀	2.66 ppb	0.035 ppb	76

Estuarine Invert. Reproduction NOAEC	1.25 - 2.34 ppb	< 0.0046 ppb	> 270 > 510
Estuarine Algae EC ₅₀	2.66 ppb	140 ppb	0.019

Risk Summary for Typical Tobacco Spray Use: Risk quotients derived for a single application at the typical use rate of 2.0 lbs ai/A on tobacco exceed the levels of concern for most non-target aquatic and terrestrial animals. The risk quotients for an average application rate is as follows: mammalian acute (0.009-4.7) and reproduction NOAEL (3.0-48), avian acute (0.22-3.5) and reproduction NOAEL (1.2-19), freshwater fish acute (1.5) and reproduction NOAEC (2.2-4.1), freshwater invertebrates acute (27) and reproduction NOAEC (31-59), estuarine fish acute (2.8) and reproduction NOAEC (4.5-8.4), and estuarine invertebrates acute (76) and reproduction NOAEC (>270->510) and estuarine algae (0.019).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 4.9 ppm and whole fish of 3.4 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm and less than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and less than the avian reproductive NOAEL of 25 ppm.

Sorghum Uses: Sorghum represents less than 1 percent of total chlorpyrifos poundage. Chlorpyrifos is applied to about 2 percent (likely maximum of 3 percent treated) of the approximately 11,000,000 acres of sorghum grown in the U.S. According to BEAD, the typical chlorpyrifos usage on sorghum is 1.1 application at 0.6 lbs ai/A on approximately 210,000 to 350,000 acres. The leading states using about 76 percent of the chlorpyrifos applied to sorghum are Texas, Mississippi, Kansas, Oklahoma, Nebraska and Louisiana.

Wildlife utilization of sorghum fields for feeding is high for many mammals and birds. Species identified as feeding heavily in sorghum in one or more states include: antelope, aoudad sheep, whitetail deer, cottontail rabbits, javelina, Ord kangaroo rat, bobwhite quail, scaled quail, ring-necked pheasants, chukar partridges greater and lesser prairie chickens, wild turkeys, mourning doves, white-winged doves, mallard ducks, geese, sandhill cranes, songbirds, crows, white-necked ravens, and English sparrows. Many other avian species feed in sorghum to a lesser degree.

Directions for sorghum use on registered labels include both spray (the major use) and granular applications. Chlorpyrifos granules are applied and soil incorporated at-plant at 1.8 oz. ai/1000 feet of row; sprayed on foliage at 0.25-1 lb ai/A by ground, sprinkler irrigation, or aerial equipment; and applied as a slurry seed treatment on stored seed at 3 fl. oz. ai/cwt. The maximum seasonal spray application rate is 1.5 lbs ai/A. The following two tables show the risk quotients for maximum use rates for sorghum at-plant granular and foliar spray applications.

<p align="center">Granular Risk Quotients for Sorghum (At Planting, 1 Application at 1.8 oz. ai/1000 feet of row; Soil Incorporation, 2-inch) (Terrestrial EEC's Based on Formula*; Aquatic EEC's Based on GENEEC Model)</p>

Species	Toxicity	Exposure	Toxicity Dose	Risk Quotient
Mammalian Acute LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	97 mg/kg	15.3 mg/ft ² *	1.5 mg 3.4 mg 97 mg	10 4.5 0.16
Avian Acute Oral LD ₅₀ (27.7 grams body wt.)	10 mg/kg	15.3 mg/ft ² *	0.28 mg	55
Freshwater Fish Acute LC ₅₀	1.8 ppb	4.2 ppb		2.3
Fish Reproduction NOAEC	0.57 ppb	2.0 - 3.6 ppb		3.5 - 6.3
Aquatic Invertebrate Acute LC ₅₀	0.10 ppb	4.2 ppb		42
Freshwater Invert. Reproduction NOAEC	0.04 ppb	2.0 - 3.6 ppb		50 - 90
Estuarine Fish Acute LC ₅₀	0.96 ppb	4.2 ppb		4.4
Estuarine Fish Reproduction NOAEC	0.28 ppb	2.0 - 3.6 ppb		7.1 - 3.8
Estuarine Invertebrate Acute LC ₅₀	0.035 ppb	4.2 ppb		120
Estuarine Invert. Reproduction NOAEC	< 0.0046 ppb	2.0 - 3.6 ppb		> 435 > 80

$$* \text{ mg ai/ft}^2 = \frac{1.8 (\text{oz ai/1000 ft row}) \times 28,349 \text{ mg/oz.} \times 15 \% \text{ exposed}}{1,000 \text{ feet row} \times \text{band width (0.5 ft.)}} = 15.3 \text{ mg ai./ft.}^2$$

$$\text{lbs ai/A} = \frac{1.8 (\text{oz. ai./1000 feet of row}) \times 43560 \text{ ft}^2/\text{A}}{16 \text{ oz./lb} \times 1000 \text{ ft} \times 2.0 \text{ row spacing (ft.)}} = 2.5 \text{ lbs/A}$$

Risk Summary for Maximum Granular At-Plant Sorghum Uses: Chlorpyrifos granules applied to sorghum in a 6-inch band at 1.8 oz. ai/1000 feet of row and soil incorporated into top 1 inch of soil yield risk quotients exceeds levels of concern for most non-target aquatic and terrestrial animals. Risk quotients are mammalian acute (0.16-10), avian acute (55), freshwater fish acute (2.3) and reproduction NOAEC (3.5-6.3), aquatic invertebrate acute (42) and reproduction NOAEC (50-90), estuarine fish acute (4.4) and reproduction NOAEC (7.1-3.8), estuarine invertebrate acute (120) and reproduction NOAEC (> 435-> 780).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 7.8 ppm and whole fish of 4.5 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm and less than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and less than the avian reproductive NOAEL of 25 ppm.

Risk Quotients for Sorghum (Foliar Spray; 1 lb ai/A; 1 Application) (Terrestrial EEC's Based on Nomograph; Aquatic EEC's Based on GENEEC Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	135 - 240 ppm	102 ppm 147 ppm 647 ppm	1.3 - 2.3 0.92 - 1.6 0.21 - 0.37

Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	15 - 135 ppm	102 ppm 147 ppm 647 ppm	0.15 - 1.3 0.10 - 0.92 0.023- 0.21
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	15 - 135 ppm	462 ppm 647 ppm 3233 ppm	0.032- 0.29 0.023- 0.21 0.005- 0.042
Mammalian Subacute Dietary LC ₅₀	135 - 240 ppm	1330 ppm	0.10 - 0.18
Mammalian Reproduction NOAEL	135 - 240 ppm	10 ppm	14 - 24
Avian Subacute Dietary LC ₅₀	135 - 240 ppm	136 ppm	0.99 - 1.8
Avian Reproduction NOAEL	135 - 240 ppm	25 ppm	5.4 - 9.6
Freshwater Fish Acute LC ₅₀	5.1 ppb	1.8 ppb	2.8
Fish Reproduction NOAEC	2.5 - 4.5 ppb	0.57 ppb	4.4 - 7.9
Aquatic Invertebrate Acute LC ₅₀	5.1 ppb	0.10 ppb	51
Freshwater Invert. Reproduction NOAEC	2.5 - 4.5 ppb	0.04 ppb	62 - 110
Estuarine Fish Acute LC ₅₀	5.1 ppb	0.96 ppb	5.3
Estuarine Fish Reproduction NOAEC	2.5 - 4.5 ppb	0.28 ppb	8.9 - 16
Estuarine Invertebrate Acute LC ₅₀	5.1 ppb	0.035 ppb	150
Estuarine Invert. Reproduction NOAEC	2.5 - 4.5 ppb	< 0.0046 ppb	> 540 > 980

Risk Summary for Maximum Foliar Spray Sorghum Uses: Aerial, foliar spray at 1 lb ai/A on sorghum poses risk quotients which exceed the levels of concern for most non-target aquatic and terrestrial animals. Risk quotients are mammalian acute (0.005-2.3), subacute dietary (0.10-0.18) and reproduction NOAEL (14-24), avian subacute dietary (0.99-1.8), and reproduction NOAEL (5.4-9.6), freshwater fish acute (2.8) and reproduction NOAEC (4.4-7.9), aquatic invertebrate acute (51) and reproduction NOAEC (62-110), estuarine fish acute (5.3) and reproduction NOAEC (8.9-16), estuarine invertebrate acute (150) and reproduction NOAEC (>540->980).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 9.8 ppm and whole fish of 6.8 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm and less than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and less than the avian reproductive NOAEL of 25 ppm.

Typical Sorghum Use: Risk quotients for typical use rates for chlorpyrifos on sorghum (0.6 lbs ai/A) are about one-half of the above aerial, foliar spray values. Risk quotients for a typical spray application on sorghum exceed the levels of concern for most non-target aquatic and terrestrial animals. Risk quotients are mammalian acute (0.002-1.1), subacute dietary (0.05-0.09) and reproduction NOAEL (7-12), avian subacute dietary (0.04-0.9), and reproduction NOAEL (2.7-4.8), freshwater fish acute (1.4) and reproduction NOAEC (2.2-3.9), aquatic invertebrate acute (25) and reproduction NOAEC (31-55), estuarine fish acute (2.6) and reproduction NOAEC (4.4-8), estuarine invertebrate acute (75) and reproduction NOAEC (>270->490).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 4.9 ppm and whole fish of 3.4 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm and less than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and less than the avian reproductive NOAEL of 25 ppm.

Soybean Uses: According to BEAD, chlorpyrifos use on soybeans is less than 1 percent of total chlorpyrifos poundage. Chlorpyrifos is applied to less than 1 percent (likely maximum of less than 1 percent treated) of the approximately 61,000,000 acres of soybeans grown in the U.S. The typical chlorpyrifos usage on sorghum is 1 application at 0.7 lbs ai/A on approximately 90,000 to 150,000 acres (the grown stage was not specified). The leading states using about 53 percent of the chlorpyrifos applied to soybeans are Illinois, Iowa, Ohio, South Dakota, Indiana, and Nebraska.

Wildlife utilization of soybean fields for feeding is high for many mammals and birds. Species identified as feeding heavily in soybeans in one or more states include: whitetail deer, raccoon, fox squirrel, groundhog, cottontail rabbits, bobwhite quail, pheasants, greater prairie chickens, wild turkey, mourning doves, ducks, and geese.

Directions for chlorpyrifos use on soybeans on registered labels include both spray (the major use) and granular formulations. Chlorpyrifos granules are applied to soybeans and soil incorporated at-plant or postemergence at 1.2 oz. ai/1000 feet of row with ground equipment; and sprayed as a soil band at-plant or postemergence with ground equipment or sprayed on foliage at 1 lb ai/A by ground, sprinkler irrigation, or aerial equipment. The maximum seasonal, spray application rate is 3 lbs ai/A. The following 2 tables show the risk quotients for maximum application rates on soybeans.

Granular Risk Quotients for Soybeans (At Planting, 1 Application at 1.2 oz. ai/1000 feet of row; 4-inch Band; Soil Incorporation, 2-inch) (Terrestrial EEC's Based on Formula*; Aquatic EEC's Based on Formula** and GENEEC Model)				
Species	Toxicity	Exposure	Toxicity Dose	Risk Quotient
Mammalian LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	97 mg/kg	15.5 mg/ft ² *	1.5 mg 3.4 mg 97 mg	10 4.6 0.16
Avian Acute Oral LD ₅₀ (27.7 grams body wt.)	10 mg/kg	15.5 mg/ft ² *	0.28 mg	55
Freshwater Fish Acute LC ₅₀	1.8 ppb	2.7 ppb		1.5
Fish Reproduction NOAEC	0.57 ppb	1.3 - 2.3 ppb		2.3 - 4.0
Aquatic Invertebrate Acute LC ₅₀	0.10 ppb	2.7 ppb		27
Freshwater Invert. Reproduction NOAEC	0.04 ppb	1.3 - 2.3 ppb		32 - 58
Estuarine Fish Acute LC ₅₀	0.96 ppb	2.7 ppb		2.8
Estuarine Fish Reproduction NOAEC	0.28 ppb	1.3 - 2.3 ppb		4.6 - 8.2

Estuarine Invertebrate Acute LC ₅₀	0.035 ppb	2.7 ppb		77
Estuarine Invert. Reproduction NOAEC	< 0.0046 ppb	1.3 - 2.3 ppb		> 280 > 500

$$* \text{ mg ai/ft}^2 = \frac{1.2 \text{ (oz ai/1000 ft row)} \times 28,349 \text{ mg/oz.} \times 15 \% \text{ exposed}}{1,000 \text{ feet row} \times \text{band width (0.33 ft.)}} = 15.5 \text{ mg ai./ft.}^2$$

$$** \text{ lbs ai/A} = \frac{1.2 \text{ (oz. ai./1000 feet of row)} \times 43560 \text{ ft}^2/\text{A}}{16 \text{ oz./lb} \times 1000 \text{ ft} \times 2.0 \text{ row spacing (ft.)}} = 1.6 \text{ lbs/A}$$

Risk Quotients for Soybeans (Foliar Spray; 1 lb ai/A; 3 Applications; 14-Day Interval) (Terrestrial EEC's Based on Fate Model; Aquatic EEC's Based on GENEEC Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	177 - 315 ppm	102 ppm 147 ppm 647 ppm	1.7 - 3.1 1.2 - 2.1 0.27 - 0.50
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	20 - 177 ppm	102 ppm 147 ppm 647 ppm	0.17 - 1.7 0.14 - 1.2 0.031 - 0.27
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	20 - 177 ppm	462 ppm 647 ppm 3233 ppm	0.043 - 0.38 0.031 - 0.27 0.006 - 0.055
Mammalian Subacute Dietary LC ₅₀	177 - 315 ppm	1330 ppm	0.13 - 0.24
Mammalian Reproduction NOAEL	177 - 315 ppm	10 ppm	18 - 32
Avian Subacute Dietary LC ₅₀	177 - 315 ppm	136 ppm	1.3 - 2.3
Avian Reproduction NOA EL	177 - 315 ppm	25 ppm	7.1 - 13
Freshwater Fish Acute LC ₅₀	16 ppb	1.8 ppb	8.9
Fish Reproduction NOAEC	7.8 - 14.3 ppb	0.57 ppb	14 - 25
Aquatic Invertebrate Acute LC ₅₀	16 ppb	0.10 ppb	160
Freshwater Invert. Reproduction NOAEC	7.8 - 14.3 ppb	0.04 ppb	200 - 360
Estuarine Fish Acute LC ₅₀	16 ppb	0.96 ppb	17
Estuarine Fish Reproduction NOAEC	7.8 - 14.3 ppb	0.28 ppb	28 - 51
Estuarine Invertebrate Acute LC ₅₀	16 ppb	0.035 ppb	460
Estuarine Invert. Reproduction NOAEC	7.8 - 14.3 ppb	< 0.0046 ppb	>1700 > 3100

Risk Summary for Maximum Soybean Uses: Granules applied at plant on soybeans at 1.2 oz. ai/1000 ft. yield risk quotients which exceed the levels of concern for most non-target aquatic and terrestrial animals. Risk quotients are mammalian acute (0.16-10), avian acute (55), freshwater fish acute (1.5) and reproduction NOAEC (2.3-4.0), aquatic invertebrate acute (27) and reproduction NOAEC (32-58), estuarine fish acute (2.8) and reproduction NOAEC (4.6-8.2), estuarine invertebrate acute (77) and reproduction NOAEC (>280->500).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 5.1 ppm and whole fish of 3.5 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm and less than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and less than the avian reproductive NOAEL of 25 ppm.

Risk quotients for chlorpyrifos sprayed three times on soybeans exceed the levels of concern for species in most non-target aquatic and terrestrial animals. Risk quotients for the three spray applications are mammalian acute (0.006-3.1), subacute dietary (0.13-0.24), and reproduction NOAEL (18-32), avian subacute dietary (1.3-2.3), and reproduction NOAEL (7.1-13), freshwater fish acute (8.9) and reproduction NOAEC (14-25), aquatic invertebrate acute (160) and reproduction NOAEC (200-360), estuarine fish acute (17) and reproduction NOAEC (28-51, estuarine invertebrate acute (460) and reproduction NOAEC (>1700->3100).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 30 ppm and whole fish of 21 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm but more than the avian reproductive NOAEL of 25 ppm.

Sunflower Uses: Chlorpyrifos use on sunflowers is less than 1 percent of the total chlorpyrifos poundage. Chlorpyrifos is applied to less than 1 percent (likely maximum of less than 1 percent treated) of the approximately 2,700,000 acres of sunflowers grown in the U.S. According to BEAD, the typical chlorpyrifos usage on sunflowers is 1.1 application at 0.7 lbs ai/A on 7,000 to 13,000 acres. The leading states using about 81 percent of the chlorpyrifos applied to sunflowers are Minnesota, Colorado, California, and Kansas.

Directions for chlorpyrifos use on sunflowers on registered labels include both spray (the major use) and granular formulations. Chlorpyrifos granules are applied in a 7-inch wide, soil band application at-planting at 1.25 oz. ai/1000 feet of row. Chlorpyrifos is sprayed preplant at 1-2 lbs ai/A by ground equipment and soil incorporated (2 to 4 inches); and as a foliar spray is applied at a 7-day minimum interval by ground or aerial equipment. Assumes 24-inch row spacing. Maximum seasonal application rate is 4.5 lbs ai/A. The following 3 tables show the risk quotients for maximum chlorpyrifos use rates on sunflowers.

Risk Quotients for Sunflowers (Preplant Soil Incorporated (2 inches) Spray Treatment; 2 lb ai/A; 1 Application) (Terrestrial EEC's Based on Nomograph; Aquatic EEC's Based on GENEEC Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.)	270 - 480 ppm	102 ppm	2.6 - 4.7
(35 grams body wt.)		147 ppm	1.8 - 3.3
(1000 grams body wt.)		647 ppm	0.42 - 0.74

Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	30 - 270 ppm	102 ppm 147 ppm 647 ppm	0.29 - 2.6 0.20 - 1.8 0.046- 0.42
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	30 - 270 ppm	462 ppm 647 ppm 3233 ppm	0.065- 0.58 0.046- 0.42 0.009- 0.084
Mammalian Subacute Dietary LC ₅₀	270 - 480 ppm	1330 ppm	0.20 - 0.36
Mammalian Reproduction NOAEL	270 - 480 ppm	10 ppm	27 - 48
Avian Subacute Dietary LC ₅₀	270 - 480 ppm	136 ppm	2.0 - 3.5
Avian Reproduction NOAEL	270 - 480 ppm	25 ppm	11 - 19
Freshwater Fish Acute LC ₅₀	4.1 ppb	1.8 ppb	2.3
Fish Reproduction NOAEC	2.0 - 3.8 ppb	0.57 ppb	3.5 - 6.7
Aquatic Invertebrate Acute LC ₅₀	4.1 ppb	0.10 ppb	41
Freshwater Invert. Reproduction NOAEC	2.0 - 3.8 ppb	0.04 ppb	50 - 95
Estuarine Fish Acute LC ₅₀	4.1 ppb	0.96 ppb	4.3
Estuarine Fish Reproduction NOAEC	2.0 - 3.8 ppb	0.28 ppb	7.1 - 14
Estuarine Invertebrate Acute LC ₅₀	4.1 ppb	0.035 ppb	120
Estuarine Invert. Reproduction NOAEC	2.0 - 3.8 ppb	< 0.0046 ppb	> 430 > 830

Granular Risk Quotients for Sunflowers (At Planting, 1 Application at 1.25 oz. ai/1000 feet of row; 7-inch Band; Soil Incorporation, 1-inch) (Terrestrial EEC's Based on Formula*; Aquatic EEC's Based on Formula** and GENEEC Model)				
Species	Toxicity	Exposure	Toxicity Dose	Risk Quotient
Mammalian Acute LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	97 mg/kg	9.16 mg/ft ²	1.5 mg 3.4 mg 97 mg	6.1 2.7 0.094
Avian Acute Oral LD ₅₀ (27.7 grams body wt.)	10 mg/kg	9.16 mg/ft ²	0.28 mg	33
Freshwater Fish Acute LC ₅₀	1.8 ppb	2.8 ppb		1.6
Fish Reproduction NOAEC	0.57 ppb	1.4 - 2.4 ppb		2.5 - 4.2
Aquatic Invertebrate Acute LC ₅₀	0.10 ppb	2.8 ppb		28
Freshwater Invert. Reproduction NOAEC	0.04 ppb	1.4 - 2.4 ppb		35 - 60
Estuarine Fish Acute LC ₅₀	0.96 ppb	2.8 ppb		2.9
Estuarine Fish Reproduction NOAEC	0.28 ppb	1.4 - 2.4 ppb		5.0 - 8.6
Estuarine Invertebrate Acute LC ₅₀	0.035 ppb	2.8 ppb		80
Estuarine Invert. Reproduction NOAEC	< 0.0046 ppb	1.4 - 2.4 ppb		> 300 > 520

* $\text{mg ai/ft}^2 = \frac{1.25 \text{ (oz ai/1000 ft row)} \times 28,349 \text{ mg/oz.} \times 15 \% \text{ exposed}}{1,000 \text{ feet row} \times \text{band width (0.58 ft.)}} = 9.16 \text{ mg ai./ft.}^2$

$$^{**} \text{ lbs ai/A} = \frac{1.25 \text{ (oz. ai./1000 feet of row)} \times 43560 \text{ ft}^2/\text{A}}{16 \text{ oz./lb} \times 1000 \text{ ft} \times 2.0 \text{ row spacing (ft.)}} = 1.7 \text{ lbs ai/A}$$

Risk Quotients for Sunflowers (Foliar Spray Treatment; 1.5 lb ai/A; 3 Applications; 7-day Interval) (Terrestrial EEC's Based on Fate Model; Aquatic EEC's Based on GENEEC Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	354 - 630 ppm	102 ppm 147 ppm 647 ppm	3.5 - 6.2 2.4 - 4.3 0.55 - 0.97
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	39 - 354 ppm	102 ppm 147 ppm 647 ppm	0.38 - 3.5 0.27 - 2.4 0.060 - 0.55
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	39 - 354 ppm	462 ppm 647 ppm 3233 ppm	0.084 - 0.77 0.060 - 0.55 0.012 - 0.11
Mammalian Subacute Dietary LC ₅₀	354 - 630 ppm	1330 ppm	0.27 - 0.47
Mammalian Reproduction NOAEL	354 - 630 ppm	10 ppm	35 - 63
Avian Subacute Dietary LC ₅₀	354 - 630 ppm	136 ppm	2.6 - 4.6
Avian Reproduction NOAEL	354 - 630 ppm	25 ppm	14 - 25
Freshwater Fish Acute LC ₅₀	25 ppb	1.8 ppb	14
Fish Reproduction NOAEC	12 - 22 ppb	0.57 ppb	21 - 39
Aquatic Invertebrate Acute LC ₅₀	25 ppb	0.10 ppb	250
Freshwater Invert. Reproduction NOAEC	12 - 22 ppb	0.04 ppb	300 - 550
Estuarine Fish Acute LC ₅₀	25 ppb	0.96 ppb	26
Estuarine Fish Reproduction NOAEC	12 - 22 ppb	0.28 ppb	43 - 79
Estuarine Invertebrate Acute LC ₅₀	25 ppb	0.035 ppb	710
Estuarine Invert. Reproduction NOAEC	12 - 22 ppb	< 0.0046 ppb	>2600 > 4800

Risk Summary for Maximum Use on Sunflowers: Risk quotients for chlorpyrifos sprayed preplant on sunflowers exceed the levels of concern for species in most non-target aquatic and terrestrial animals. Risk quotients are mammalian acute (0.009-4.7), subacute dietary (0.20-0.36), and reproduction NOAEL (27-48), avian subacute dietary (2.0-3.5), and reproduction NOAEL (11-19), freshwater fish acute (2.3) and reproduction NOAEC (3.5-6.7), aquatic invertebrate acute (41) and reproduction NOAEC (50-95), estuarine fish acute (4.3) and reproduction NOAEC (7.1-14), estuarine invertebrate acute (120) and reproduction NOAEC (>430->830).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 7.8 ppm and whole fish of 5.4 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm and less than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and less than the avian

reproductive NOAEL of 25 ppm.

Chlorpyrifos granules applied in a 7-inch band at plant on sunflowers exceed the levels of concern for most non-target aquatic and terrestrial wildlife. Risk quotients are mammalian acute (0.094-6.1), avian acute (33), freshwater fish acute (1.6) and reproduction NOAEC (2.5-4.2), aquatic invertebrate acute (28) and reproduction NOAEC (35-60), estuarine fish acute (2.9) and reproduction NOAEC (5.0-8.6), estuarine invertebrate acute (80) and reproduction NOAEC (>300->520).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 5.5 ppm and whole fish of 3.8 ppm. These levels are less than the mammalian subacute LC_{50} value of 1330 ppm and less than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC_{50} value of 136 ppm and less than the avian reproductive NOAEL of 25 ppm.

Chlorpyrifos sprayed 3 times on sunflowers at 1.5 lbs ai/A yield risk quotients which exceed the levels of concern for species in most non-target aquatic and terrestrial animals. Risk quotients are mammalian acute (0.012-6.2), subacute dietary (0.27-0.47), and reproduction NOAEL (35-63), avian subacute dietary (2.6-4.6), and reproduction NOAEL (14-25), freshwater fish acute (14) and reproduction NOAEC (21-39), aquatic invertebrate acute (250) and reproduction NOAEC (300-550), estuarine fish acute (26) and reproduction NOAEC (300-550), estuarine invertebrate acute (710) and reproduction NOAEC (>2600->4800).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 47 ppm and whole fish of 33 ppm. These levels are less than the mammalian subacute LC_{50} value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC_{50} value of 136 ppm but more than the avian reproductive NOAEL of 25 ppm.

(iv) Vegetable Crops and Strawberries

Chlorpyrifos may be applied to many kinds of vegetables. While there is a wide variety of treatments specific to a particular vegetable, two application methods are common for most vegetables (band treatment at plant and 6 foliar applications).

Vegetable Uses: Chlorpyrifos use on each vegetable and strawberries represents less than 1 percent of total chlorpyrifos poundage. Acreage and typical chlorpyrifos use rates on vegetables are listed by crop.

Directions for chlorpyrifos use on registered labels include both spray and granular formulations. Granules and spray may be applied by ground equipment at planting/transplanting or post-transplant as a 4-inch wide band over the row typically at maximum use rates of 1.4 oz. ai/1,000 feet of row (maximum use rates on some vegetables range from 1.2 to 1.8 oz. ai/1,000 feet of row). Six foliar applications at 1 lb ai/A may be sprayed with ground or aerial equipment.

Peppers and tomatoes may be sprayed 8 times at 1 lb ai/A in Florida and Georgia.

Applications to the remaining field crops are of three types (slurry seed treatments, foliar sprays, and soil applications. Slurry seed treatments for stored seed (3 fl. oz. ai/cwt) and preplant seed (1 oz. ai/cwt), which are the same rates and result in the same risks as calculated for corn. Crops with treated seeds are beans and peas (both); cucumbers and pumpkins (preplant seeds only). Foliar applications are sprayed on asparagus foliar spray once or twice (1 lb ai/A, limited to AZ, CA, midwest, and Pacific northwest); carrots grown for seed (1 lb ai/A); and strawberries (twice at 1 lb ai/A). At plant soil applications include spraying broccoli raab (rapini) (2.25 lbs ai/A); Chinese broccoli (gai lon) (2.25 lbs ai/A); bulb onions (0.045 lb ai/1000 ft soil drench at 0.035 lb ai/1000 ft); radish (granular and spray in-furrow at 0.5 oz. ai/1000 ft); radish grown for seed (2 lbs ai/A); strawberries (2 lbs ai/A, limited to ID, OR, and WA); sugar beets grown for seed are sprayed at 2 lb ai/A; and sweet potatoes at 2 lbs ai/A incorporated. Risk quotients for seed treatments are the same as for corn slurry seed treatments. The following 3 tables show the risk quotients for vegetable crops.

Granular Risk Quotients for Vegetables Broccoli, Brussel Sprouts, Cabbage, Cauliflower, Chinese Cabbage, Collards, Kale, Kohlrabi, Rutabagas, and Turnips (4-Inch Band at Plant/transplant; 1 Application at 1.4 oz. ai/1000 ft; 2-inch Soil Incorporation) (Terrestrial EEC's Based on Formula*; Aquatic EEC's Based on Formula** and GENEEC Model)				
Species	Toxicity	Exposure	Toxicity Dose	Risk Quotient
Mammalian Acute LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	97 mg/kg	20 mg/ft ² *	1.5 mg 3.4 mg 97 mg	13 5.9 0.21
Avian Acute Oral LD ₅₀ (27.7 grams body wt.)	10 mg/kg	20 mg/ft ² *	0.28 mg	71
Freshwater Fish Acute LC ₅₀	1.8 ppb	3.2 ppb		1.8
Fish Reproduction NOAEC	0.57 ppb	1.6 - 2.7 ppb		2.8 - 4.7
Aquatic Invertebrate Acute LC ₅₀	0.10 ppb	3.2 ppb		32
Freshwater Invert. Reproduction NOAEC	0.04 ppb	1.6 - 2.7 ppb		40 - 68
Estuarine Fish Acute LC ₅₀	0.96 ppb	3.2 ppb		3.3
Estuarine Fish Reproduction NOAEC	0.28 ppb	1.6 - 2.7 ppb		5.7 - 9.6
Estuarine Invertebrate Acute LC ₅₀	0.035 ppb	3.2 ppb		91
Estuarine Invert. Reproduction NOAEC	< 0.0046 ppb	1.6 - 2.7 ppb		>350 > 590

$$* \text{ mg ai/ft}^2 = \frac{(1.4 \text{ oz ai/1000 ft row}) \times 28,349 \text{ mg/oz.} \times 15 \% \text{ exposed}}{1,000 \text{ feet row} \times \text{band width (0.3 ft.)}} = 20 \text{ mg ai./ft.}^2$$

$$** \text{ lbs ai/A} = \frac{1.4 \text{ (oz. ai./1000 feet of row)} \times 43560 \text{ ft}^2/\text{A}}{16 \text{ oz./lb} \times 1000 \text{ ft} \times 2.0 \text{ row spacing (ft.)}} = 1.9 \text{ lbs/A}$$

Risk Quotients for Vegetables Broccoli*, Brussel Sprouts*, Cabbage*, Chinese Cabbage, Collards, Kale, Kohlrabi, and Turnips (4-Inch Band Spray at Plant/transplant; 1 Application at 2.75 fl. oz. ai/1000 ft) (Terrestrial EEC's Based on 11.3 lb ai/A in Band; Aquatic EEC's Based on GENEEC Model for 1.9 lb ai/A)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	170 - 1526 ppm	102 ppm 147 ppm 647 ppm	1.7 - 15 1.2 - 10 0.26 - 2.4
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	170 - 1526 ppm	462 ppm 647 ppm 3233 ppm	0.37 - 3.3 0.26 - 2.4 0.053- 0.47
Mammalian Subacute Dietary LC ₅₀	170 - 1526 ppm	1330 ppm	0.13 - 1.1
Mammalian Reproduction NOAEL	170 - 1526 ppm	10 ppm	17 - 150
Avian Subacute Dietary LC ₅₀	170 - 1526 ppm	136 ppm	1.2 - 11
Avian Reproduction NOAEL	170 - 1526 ppm	25 ppm	6.8 - 61
Freshwater Fish Acute LC ₅₀	3.9 ppb	1.8 ppb	2.2
Fish Reproduction NOAEC	1.9 - 3.4 ppb	0.57 ppb	3.3 - 6.0
Aquatic Invertebrate Acute LC ₅₀	3.9 ppb	0.10 ppb	39
Freshwater Invert. Reproduction NOAEC	1.9 - 3.4 ppb	0.04 ppb	48 - 85
Estuarine Fish Acute LC ₅₀	3.9 ppb	0.96 ppb	4.1
Estuarine Fish Reproduction NOAEC	1.9 - 3.4 ppb	0.28 ppb	6.8 - 12
Estuarine Invertebrate Acute LC ₅₀	3.9 ppb	0.035 ppb	110
Estuarine Invert. Reproduction NOAEC	1.9 - 3.4 ppb	< 0.0046 ppb	>410 > 740

* In California, a second application may be applied when plants are thinned.

$$\text{lb ai/A in band} = \frac{2.75 \text{ (fl oz/1,000 ft)} \times 4 \text{ lb ai/gal} \times 43560 \text{ ft.}^2/\text{A}}{128 \text{ fl. oz./gal.} \times 1000 \text{ ft.} \times \text{band width (0.33 ft.)}} = 11.3 \text{ lb ai/A in band}$$

Risk Quotients for Vegetables Broccoli, Brussel Sprouts, Cabbage, Cauliflower, Chinese Broccoli, Chinese Cabbage, Chinese Mustard, Collards, Kale, Kohlrabi, Mustard Greens, and Rape (Aerial Foliar Spray; 6 Applications at 1 lb ai/A) (Terrestrial EEC's Based on Nomograph; Aquatic EEC's Based on GENEEC Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	266 - 472 ppm	102 ppm 147 ppm 647 ppm	2.6 - 4.6 1.8 - 3.2 0.41 - 0.73
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	30 - 266 ppm	102 ppm 147 ppm 647 ppm	0.29 - 2.6 0.20 - 1.8 0.046- 0.41
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	30 - 266 ppm	462 ppm 647 ppm 3233 ppm	0.065- 0.58 0.046- 0.41 0.009- 0.082

Mammalian Subacute Dietary LC ₅₀	266 - 472 ppm	1330 ppm	0.20 - 0.35
Mammalian Reproduction NOAEL	266 - 472 ppm	10 ppm	27 - 47
Avian Subacute Dietary LC ₅₀	266 - 472 ppm	136 ppm	2.0 - 3.5
Avian Reproduction NOAEL	266 - 472 ppm	25 ppm	11 - 19
Freshwater Fish Acute LC ₅₀	32 ppb	1.8 ppb	18
Fish Reproduction NOAEC	15 - 28 ppb	0.57 ppb	26 - 49
Aquatic Invertebrate Acute LC ₅₀	32 ppb	0.10 ppb	320
Freshwater Invert. Reproduction NOAEC	15 - 28 ppb	0.04 ppb	380 - 700
Estuarine Fish Acute LC ₅₀	32 ppb	0.96 ppb	33
Estuarine Fish Reproduction NOAEC	15 - 28 ppb	0.28 ppb	54 - 100
Estuarine Invertebrate Acute LC ₅₀	32 ppb	0.035 ppb	910
Estuarine Invert. Reproduction NOAEC	15 - 28 ppb	< 0.0046 ppb	>3300 > 6100

Risk Summary for Maximum Use Rates on Vegetables: Granular band treatments with 1.4 oz. ai/A chlorpyrifos to vegetables yield risk quotients which exceed the level of concern for most non-target aquatic and terrestrial animals. The range of risk quotients are mammalian acute (0.21-13), avian acute (71), freshwater fish acute (1.8) and reproduction NOAEC (2.8-4.7), aquatic invertebrate acute (32) and reproduction NOAEC (40-68), estuarine fish acute (3.3) and reproduction NOAEC (5.7-9.6), estuarine invertebrate acute (91) and reproduction NOAEC (>350->590).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 6.2 ppm and whole fish of 4.4 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm and less than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and less than the avian reproductive NOAEL of 25 ppm.

Risk quotients for other granular band application rates (per 1000 feet of row) are less than 1.4 oz. discussed above: bulb onions (0.035 lb), and sugar beets (1.35 oz.).

An at-plant/transplant 4-inch band treatment of chlorpyrifos to vegetables listed in the above table yields risk quotients which exceed the levels of concern in most non-target aquatic and terrestrial animals. Risk quotients are mammalian acute (0.53-15), subacute dietary (0.13-1.1), and reproduction NOAEL (17-150), avian subacute dietary (1.2-11) and reproduction NOAEL (6.8-61), freshwater fish acute (2.2) and reproduction NOAEC (3.3-6.0), aquatic invertebrate acute (39) and reproduction NOAEC (48-85), estuarine fish acute (4.1) and reproduction NOAEC (6.8-12), estuarine invertebrate acute (110) and reproduction NOAEC (>410->740).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 7.4 ppm and whole fish of 5.2 ppm. These levels are less than the mammalian subacute LC₅₀

value of 1330 ppm and less than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and less than the avian reproductive NOAEL of 25 ppm.

Lower risk quotients occur for other liquid soil applications, such as band, sidedress, soil drench, and soil injection applications (per 1000 feet of row) are: 0.04 lb on bulb onions, 0.5 oz. on radish, 1.2 oz. on cauliflower, 1.3 oz. on broccoli, cabbage, and 1.3 and 1.6 oz. on rutabagas, compared to the above 2.75 fl. oz. assessment.

Chlorpyrifos is sprayed as a 4-inch wide band over the row at plant with shallow soil incorporation. As the fields for these crops are usually well cultivated, short grass and other vegetation are unlikely. Insect and seeds may be sprayed and available to wildlife. While soil incorporation does not reduce the pesticide concentration on sprayed items, soil may cover some items and reduce their availability.

Six aerial, foliar spray treatments of chlorpyrifos to vegetables listed in above table yield risk quotients which exceed the levels of concern for most non-target aquatic and terrestrial animals. Risk quotients for the six spray applications are mammalian acute (0.009-4.6), subacute dietary (0.20-0.35), and reproduction NOAEL (27-47), avian subacute dietary (2.0-3.5) and reproduction NOAEL (11-19), freshwater fish acute (18) and reproduction (26-49), aquatic invertebrate acute (320) and reproduction (380-700), estuarine fish acute (33) and reproduction (54-100), estuarine invertebrate acute (910) and reproduction (>3300->6100).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 59 ppm and whole fish of 41 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm but more than the avian reproductive NOAEL of 25 ppm.

(v) Citrus Grove Applications (foliar, grove floor)

Citrus Uses: Citrus use represents about 3 percent of the total chlorpyrifos poundage. Chlorpyrifos is mainly applied to citrus as a air-blast, foliar spray with a minor use of granular formulations for grove floor applications. Registered citrus crops include grapefruit, lemons, oranges, and other citrus groves including limes, tangelos and tangerines. According to BEAD, chlorpyrifos is applied to oranges on about 60 percent (likely maximum) of the total US acreage; grapefruit on about 12 percent (16 percent is likely maximum) or approximately 23,000 to 32,000 acres; lemons on about 30 percent (43 percent is likely maximum) or approximately 19,000 to 27,000 acres; and other citrus (including kumquats, limes, tangelos and tangerines) on about 16 percent (32 percent is likely maximum) of the total US acreage or about 8,000 to 16,000 acres. Maximum and typical risks for chlorpyrifos on citrus are assessed only for applications to oranges, because oranges represent the highest use rate and largest acreage of any citrus crop.

Directions for chlorpyrifos use on oranges on registered labels include foliar spray and granular

grove floor treatments. Two foliar applications may be sprayed with a minimum of 30-day interval. Treatments may be made either aerially or airblast by ground equipment. Use rates vary by geographic area (3.5 lbs ai/A in Florida and Texas; and 6 lbs ai/A in Arizona and California). The maximum seasonal use rate is 7.5 lbs ai/A.

Granules or spray soil broadcasts to grove floor may be applied at 1 lb ai/A with 10 applications per treatment (seasonal maximum of 10 lbs ai/A; limited to 3 lb ai/A EC in Florida). It is assumed that granules do not persist until the next application. Runoff from citrus orchards which usually have bare ground is typically higher than for pome and other orchards which have ground cover.

The use rate for residential citrus is 0.5 lb ai/100 gallons (600 ppm). Trunks may be sprayed at 0.625 lb ai/A (limited to California).

Risk Quotients for Citrus in Osceola Co., Florida (Foliar Airblast Spray at 5 percent spray drift; 3.5 lbs ai/A; 2 Applications; 30-Day Interval) (Terrestrial EEC's Based on FATE Model; Aquatic EEC's Based on PRZM3.12-EXAMS Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	497 - 883 ppm	102 ppm 147 ppm 647 ppm	4.9 - 8.7 3.4 - 6.0 0.77 - 1.4
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	55 - 497 ppm	102 ppm 147 ppm 647 ppm	0.54 - 4.9 0.37 - 3.4 0.085 - 0.77
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	55 ppm	462 ppm 647 ppm 3233 ppm	0.12 0.085 0.017
Mammalian Subacute Dietary LC ₅₀	55 - 883 ppm	1330 ppm	0.041 - 0.66
Mammalian Reproduction NOAEL	55 - 883 ppm	10 ppm	5.5 - 88
Avian Subacute Dietary LC ₅₀	55 - 883 ppm	136 ppm	0.40 - 6.5
Avian Reproduction NOAEL	55 - 883 ppm	25 ppm	2.2 - 35
Freshwater Fish Acute LC ₅₀	37.3 ppb	1.8 ppb	21
Fish Reproduction NOAEC	18.7 - 30.9 ppb	0.57 ppb	33 - 54
Aquatic Invertebrate Acute LC ₅₀	37.3 ppb	0.10 ppb	370
Freshwater Invert. Reproduction NOAEC	18.7 - 30.9 ppb	0.04 ppb	470 - 770
Estuarine Fish Acute LC ₅₀	37.3 ppb	0.96 ppb	39
Estuarine Fish Reproduction NOAEC	18.7 - 30.9 ppb	0.28 ppb	67 - 110
Estuarine Invertebrate Acute LC ₅₀	37.3 ppb	0.035 ppb	1100
Estuarine Invert. Reproduction NOAEC	18.7 - 30.9 ppb	< 0.0046 ppb	> 4100 > 6700

Risk Summary for Maximum Citrus Spray Uses: Two airblast spray treatments with chlorpyrifos to citrus yield risk quotients which exceed the level of concern for most non-target

aquatic and terrestrial animals. The range of risk quotients for the two spray applications are mammalian acute (0.017-8.7), subacute dietary (0.041-0.66), and reproduction NOAEL (5.5-88), avian subacute dietary (0.40-6.5), and reproduction NOAEL (2.2-35), freshwater fish acute (21) and reproduction NOAEC (33-54), aquatic invertebrate acute (370) and reproduction NOAEC (470-770), estuarine fish acute (39) and reproduction NOAEC (67-110), estuarine invertebrate acute (1100) and reproduction NOAEC (>4100->6700). These risk quotients would be even higher for a single 6 lbs ai/A application in Arizona and California.

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 73 ppm and whole fish of 51 ppm. These levels are less than the mammalian subacute LC50 value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC50 value of 136 ppm but more than the avian reproductive NOAEL of 25 ppm.

Granular Risk Quotients for Citrus Grove Floor (Soil Broadcast, Unincorporated; 1 lb ai/A; 10 Applications) (Terrestrial EEC's Based on Formula* for one Application; Aquatic EEC's for 10 Applications Based on GENEEC Model)				
Species	Toxicity	Exposure	Toxicity Dose	Risk Quotient
Mammalian Acute LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	97 mg/kg	10.4 mg/ft ² *	1.5 mg 3.4 mg 97 mg	6.9 3.1 0.11
Avian Acute Oral LD ₅₀ (27.7 grams body wt.)	10 mg/kg	10.4 mg/ft ² *	0.28 mg	37
Freshwater Fish Acute LC ₅₀	1.8 ppb	30 ppb		17
Fish Reproduction NOAEC	0.57 ppb	15 - 26 ppb		26 - 46
Aquatic Invertebrate Acute LC ₅₀	0.10 ppb	30 ppb		300
Freshwater Invert. Reproduction NOAEC	0.04 ppb	15 - 26 ppb		370 - 650
Estuarine Fish Acute LC ₅₀	0.96 ppb	30 ppb		31
Estuarine Fish Reproduction NOAEC	0.28 ppb	15 - 26 ppb		53 - 93
Estuarine Invertebrate Acute LC ₅₀	0.035 ppb	30 ppb		860
Estuarine Invert. Reproduction NOAEC	< 0.0046 ppb	15 - 26 ppb		>3300 >5700

$$* \text{ mg ai/foot}^2 = \frac{1.0 \text{ lb ai/A} \times 453,590 \text{ mg/lb}}{43,560 \text{ ft}^2} = 10.4 \text{ mg/ft}^2$$

Risk Summary for Maximum Citrus Grove Floor Granular Uses: Ten granular chlorpyrifos broadcast treatments to citrus grove floor yield risk quotients which exceed the levels of concern for non-target aquatic and terrestrial animals. The risk quotients are mammalian acute (0.11-6.9), avian acute oral (37), freshwater fish acute (17) and reproduction NOAEC (26-46), aquatic invertebrate acute (300) and reproduction NOAEC (370-650), estuarine fish acute (31) and reproduction NOAEC (53-93), estuarine invertebrate acute (860) and reproduction NOAEC (>3300->5700).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 59 ppm and whole fish of 41 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm but more than the avian reproductive NOAEL of 25 ppm.

The aquatic risk quotients are slightly less than the risk quotients presented below for ground spray, because ground spray produces 1 percent spray drift while granular formulations do not cause any spray drift; runoff is equal for both formulations.

Risk Quotients for Citrus Grove Floor (Ground Spray or Sprinkler Irrigation; 1 lb ai/A; 10 Applications; Assume 7-Day Interval) (Terrestrial EEC's Based on FATE Model; Aquatic EEC's Based on GENEEC Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores and (15 grams body wt.) Mammalian Insectivores LD ₅₀ (35 grams body wt.) (1000 grams body wt.)	30 - 270 ppm (no grass in citrus groves)	102 ppm 147 ppm 467 ppm	0.29 - 2.6 0.20 - 1.8 0.046- 0.42
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	30 - 270 ppm	462 ppm 647 ppm 3233 ppm	0.065- 0.58 0.046- 0.42 0.009- 0.084
Mammalian Subacute Dietary LC ₅₀	30 - 270 ppm	1330 ppm	0.022- 0.20
Mammalian Reproduction NOAEL	30 - 270 ppm	10 ppm	3.0 - 27
Avian Subacute Dietary LC ₅₀	30 - 270 ppm	136 ppm	0.22- 2.0
Avian Reproduction NOAEL	30 - 270 ppm	25 ppm	1.2 - 11
Freshwater Fish Acute LC ₅₀	34 ppb	1.8 ppb	19
Fish Reproduction NOAEC	17 - 30 ppb	0.57 ppb	30 - 53
Aquatic Invertebrate Acute LC ₅₀	34 ppb	0.10 ppb	340
Freshwater Invert. Reproduction NOAEC	17 - 30 ppb	0.04 ppb	420 - 750
Estuarine Fish Acute LC ₅₀	34 ppb	0.96 ppb	35
Estuarine Fish Reproduction NOAEC	17 - 30 ppb	0.28 ppb	61 - 110
Estuarine Invertebrate Acute LC ₅₀	34 ppb	0.035 ppb	970
Estuarine Invert. Reproduction NOAEC	17 - 30 ppb	< 0.0046 ppb	> 3700 > 6500

Risk Summary for Maximum Citrus Grove Floor Spray Uses: Ten soil broadcast spray treatments with chlorpyrifos to citrus yield risk quotients which exceed the level of concern for most non-target aquatic and terrestrial animals. Risk quotients for ten spray applications are mammalian acute (0.08-2.6), subacute dietary (0.02-0.2), and reproduction NOAEL (3.0-27), avian subacute dietary (0.22-2.0), and reproduction NOAEL (1.2-11), freshwater fish acute (19) and reproduction NOAEC (30-53), aquatic invertebrate acute (340) and reproduction NOAEC (420-750), estuarine fish acute (35) and reproduction NOAEC (61-110), estuarine invertebrate

acute (970) and reproduction NOAEC (>3700->6500).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 66 ppm and whole fish of 46 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm but more than the avian reproductive NOAEL of 25 ppm.

California Citrus Field Study: A California citrus field study reported the results of airblast treatments twice per season with chlorpyrifos. One set of orange groves were sprayed at 1.5 and a second treatment at 6 lbs ai/A; and another set of groves were treated at 3.5 and 4.0 lbs ai/A. Chlorpyrifos residue levels were measured in various environmental samples and wildlife were observed for adverse effects.

Comparison of predicted residue levels of chlorpyrifos using the methodology in the above risk assessment with measured residue levels from a California orange field study are presented in the table below. In the field study, chlorpyrifos (i.e., Lorsban 4 E) was sprayed on two plots (A and B) with 4 fields each. Each field was treated with 2 applications: 1.5 plus 6.0 lbs ai/A on plots (A) and 3.5 plus 4.0 lbs ai/A on plots (B)). Soils were sampled to a depth of 1 inch. Residues on soils immediately after treatment are likely to be found in the top 1 cm. Chlorpyrifos residues in soil have not been modified in the tables below, but a reasonable estimate is that the residues may be 2.5 times higher than reported, at least initially.

CHLORPYRIFOS IN CITRUS PLOTS (A) AIRBLAST AT 1.5 & 6.0 LB AI/A				
Substrate (1st & 2nd Appl.)	Initial Mean Conc.	Initial Mean Ranges	Highest Conc.	EEB Initial EEC
1st Soil (1 in.)	2.28 ppm	0.56-4.45 ppm	5.68 ppm	3.3 ppm
2nd Soil (1 in.)	6.65 ppm	0.66-22.1 ppm	48.1 ppm	13.4 ppm
1st Crop Foliage	29.9 ppm	17.8-42.8 ppm	61.6 ppm	202.5 ppm
2nd Crop Foliage	166 ppm	61.0-310 ppm	376.2 ppm	820 ppm
1st Non-crop Foliage	6.13 ppm	0.76-12.4 ppm	23.77 ppm	10.1 ppm
2nd Non-crop Foliage	36.4 ppm	8.61-68.9 ppm	179.22 ppm	41 ppm
1st Invertebrates	5.49 ppm	3.73-5.89 ppm	13.9 ppm	22.5 ppm
2nd Invertebrates	14.2 ppm	5.00-22.1 ppm	34.79 ppm	23.6 ppm
1st Water (ppb)	< 1.0 ppb	not detected	< 1.0 ppb	7.64 ^b ppb
2nd Water (ppb)	244 ^a ppb	1.12-486 ppb	486 ppb	21.4-27.6 ^c ppb

^a Two water samples on Day 1 reported 1.18 ppb and 486.135 ppb in the only two samples collected on Day 1 of the second application at 6 lbs ai/A.

^b Aquatic EECs for 96-hour and peak conc. for airblast spray (GENEEC Model)

^c EECs for 96-hour and peak conc. for airblast spray (PRZM3-EXAMS Model)

CHLORPYRIFOS IN CITRUS PLOTS (B) AIRBLAST AT 3.5 & 4.0 LB AI/A				
Substrate (1st & 2nd Appl.)	Initial Mean Conc.	Initial Mean Ranges	Highest Conc.	EEB Initial EEC
1st Soil (1 in.)	7.63 ppm	6.23-9.37 ppm	13.41 ppm	7.71 ppm
2nd Soil (1 in.)	7.81 ppm	2.70-17.1 ppm	28.4 ppm	8.82 ppm
1st Crop Foliage	110 ppm	77.4-167 ppm	220 ppm	472.5 ppm
2nd Crop Foliage	117 ppm	46.5-209 ppm	305.8 ppm	564 ppm
1st Non-crop Foliage	21.9 ppm	12.8-41.8 ppm	91.7 ppm	23.6 ppm
2nd Non-crop Foliage	80.6 ppm	22.9-182 ppm	344.82 ppm	28.2 ppm
1st Invertebrates	4.53 ppm	3.11-5.44 ppm	8.99 ppm	52.5 ppm
2nd Invertebrates	4.99 ppm	4.19-5.67 ppm	6.97 ppm	62.7 ppm
1st Water (ppb)	0.77 ^a ppb	12.0-0.77 ppb	1.041 ppb	18.02 ^b ppb
2nd Water (ppb)	1.63 ^a ppb	<1.0-1.63 ppb	2.27 ppb	29.7 ^c ppb

^a Water sample on Day 4 reported 1.041 ppb, substituted for Day 0 levels

^b Aquatic EECs were estimated using the GENEEC Model for airblast

^c EFGWB's estimated EEC in water was 27.6 ppb using PRZM3-EXAMS Model for 2 applications at 3.5 lbs ai/A

Comparison of measured chlorpyrifos residue levels and estimated EECs indicate that EECs are generally comparable to measured levels. Soil EECs are within the range of mean measured for all four comparisons. As a conservative estimate of risk, the EECs of pesticide residue levels on foliage and on/in invertebrates are based on upper residue levels, not mean residue levels. Crop foliar EECs exceed the highest measured levels on crop foliage by 2 to 3 fold (only 3 measured samples per replicate, 12 per treatment, were collected immediately after application). Assuming that 5 percent spray drift to adjacent vegetation, non-crop foliage EECs are consistently less than the measured residue levels (2 to 12 fold). Without knowing what invertebrates were sampled, it is assumed that the residues would be 15 ppm per lb ai/A applied. EECs for invertebrates are exceeded by the highest measured residue levels in 3 out of 4 cases (2 to 9 fold).

Predicted aquatic EECs for citrus use were within the range of measured chlorpyrifos levels in adjacent bodies of water, despite many indiscernible environmental variables. Comparability of aquatic EECs with measured residues in adjacent bodies of water is dependent on many non-chemical specific factors which may not be known, such as rainfall, runoff, treated fields and adjacent water body.. Runoff to aquatic areas is an episodic event which depends on the frequency, intensity, and amount of rainfall, as well as soil type, soil water content, slope and ground cover. The chemical loading is also dependent on what percentage of the drainage area has been treated, the width and type of vegetative buffer strip, and the proximity of the treated field to the water. Also important are the dilution factors, such as the depth and volume of the water body, is the water impounded or flowing, and the amount of suspended particulates and organic matter in the water. Given all these variables, exact estimates of EECs are unlikely. Despite these numerous factors and the infrequency of rain in California, the predicted EECs

(7.64 to 29.7 ppb) were bracketed by the range of actual measured chlorpyrifos levels in the water (non-detect to 486 ppb). Measured chlorpyrifos levels in water which ranged from 1.041 to 486 ppb, were found in the water bodies adjacent to half of the treated fields in this study (i.e., replicates A2, A3, B1, and B2).

Wildlife Mortality and Sublethal Observations: Results from the California citrus field study confirmed risks to terrestrial wildlife and aquatic organisms. The results from wildlife searches yielded a total of 116 carcasses in chlorpyrifos-treated citrus groves. Only 21 carcasses were analyzed for chlorpyrifos residues and six of the 21 carcasses (28.6 %) were found to have chlorpyrifos residues either in the carcass or on their pelt and consequently it is assumed that they may have died from treatments. Out of forty carcasses found in citrus groves sprayed at 1.5 lbs ai/A, 7 carcasses were tested for chlorpyrifos and no carcasses were found to contain measureable levels of chlorpyrifos. Out of 31 carcasses found after a second application at 6 lbs ai/A, 7 carcasses were analyzed and chlorpyrifos was found on or in 4 carcasses (i.e., 5.39 ppm on the pelt of a mockingbird, 1.53 ppm on a ground squirrel pelt, 1.51 ppm on a pocket gopher's pelt, and 1.74 ppm and 6.94 ppm in the carcass and on the pelt of a western rattlesnake, respectively. Out of thirty carcasses found in citrus groves sprayed at 3.5 lbs ai/A, 6 carcasses were analyzed for chlorpyrifos and one carcass contained 0.610 ppm chlorpyrifos in the whole house mouse. Out of 15 carcasses found after a second application at 4 lbs ai/A, 1 carcass was analyzed for chlorpyrifos and 3.67 ppm was found in the young passerine nestling. Carcasses found on reference (control) replicates were not analyzed for the cause of death, because the authors assumed that all reference deaths represent natural deaths. Carcass recovery rates ranged from 21.8 to 26.3 % for the grove interior, 24.1 to 31.3 % for the grove perimeter, and 14.0 to 18.9 % for the adjacent habitat.

Residues in the rattlesnake are difficult to understand, unless the snake died after eating one or more animals which were poisoned by chlorpyrifos. If the death of the rattlesnake was caused by eating poisoned animals, it is the first known example of secondary toxicity with chlorpyrifos (i.e., residues in a dead carcass killing a scavenger). If secondary toxicity was the cause of death for the rattlesnake, other scavenging animal species might be also be at risk.

Measured chlorpyrifos levels ranging from 1.041 to 486 ppb, were found in water adjacent to half of the treated fields in this study (i.e., A2, A3, B1, and B2). Chlorpyrifos levels of 1 ppb and higher would be lethal to aquatic invertebrates, tadpoles, and small fish. The 486 ppb chlorpyrifos in water exceeds the LC50 values for all 10 freshwater and 11 estuarine fish species as well as all 4 aquatic and 6 estuarine invertebrate species for which LC50 values are available.

Although the field study was limited to collection of residue samples and observation of terrestrial effects, dead fish were found in ponds next to chlorpyrifos-treated citrus groves. The fish kills occurred, even though rainfall was slight in only one replicate during the study. The authors collected the dead fish and sent the dead fish to Dow Chemical Company.

Typical Citrus Use: According to BEAD, considerable differences exist between usage on different citrus crops ranging from 1.2 lbs ai/A on limes, tangelos and tangerines to 2.9 lbs ai/A on

oranges. Typically, second applications are made to all citrus crops. The typical use rate on oranges is about 1.3 applications at an average rate of about 2.9 lbs ai/A on approximately 120,000 to 160,000 acres with a second application on 30 percent of the treated orange acreage. Since oranges are the largest use on citrus, the risk quotients presented below are for the typical use on oranges. The leading states using 96 percent of the chlorpyrifos applied to oranges are California and Florida. According to Dow (1999 responses), the typical use for chlorpyrifos on oranges is a single foliar, air blast application at 6.0 lbs ai/A in California.

Risk Quotients for Typical Use on Oranges (Foliar, Air Blast Spray with 5 Percent spray Drift; 1 Application at 6.0 lbs ai/A) (Terrestrial EEC's Based on Nomograph; Aquatic EEC's Based on GENEEC Model)			
Surrogate Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	810 - 1440 ppm	102 ppm 147 ppm 647 ppm	7.9 - 14 5.5 - 9.8 1.3 - 2.2
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	90 - 810 ppm	102 ppm 147 ppm 647 ppm	0.88 - 7.9 0.61 - 5.5 0.14 - 1.3
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	90 - 810 ppm	462 ppm 647 ppm 3233 ppm	0.19 - 1.8 0.14 - 1.3 0.028 - 0.25
Mammalian Subacute Dietary LC ₅₀	90 - 1440 ppm	1330 ppm	0.068 - 1.1
Mammalian Reproduction NOAEL	90 - 1440 ppm	10 ppm	9.0 - 140
Avian Subacute Dietary LC ₅₀	90 - 1440 ppm	136 ppm	0.66 - 11
Avian Reproduction NOAEL	90 - 1440 ppm	25 ppm	3.6 - 58
Freshwater Fish Acute LC ₅₀	30.9 ppb	1.8 ppb	17
Fish Reproduction NOAEC	15.6 - 27.6 ppb	0.57 ppb	27 - 48
Aquatic Invertebrate Acute LC ₅₀	30.9 ppb	0.10 ppb	310
Freshwater Invert. Reproduction NOAEC	15.6 - 27.6 ppb	0.04 ppb	390 - 690
Estuarine Fish Acute LC ₅₀	30.9 ppb	0.96 ppb	32
Estuarine Fish Reproduction NOAEC	15.6 - 27.6 ppb	0.28 ppb	56 - 99
Estuarine Invertebrate Acute LC ₅₀	30.9 ppb	0.035 ppb	880
Estuarine Invert. Reproduction NOAEC	15.6 - 27.6 ppb	< 0.0046 ppb	> 3400 > 6000

Risk Summary for Typical Citrus Foliar Use: Risk quotients derived for a single application at the typical use rate at 6.0 lbs ai/A on oranges exceed the levels of concern of most non-target aquatic and terrestrial animals. The range of RQs for a typical application is as follows: mammalian acute (0.028-14) and reproduction NOAEL (9.0-140), avian acute (0.66-11) and reproduction NOAEL (3.6-58), freshwater fish acute (17) and reproduction NOAEC (27-48),

freshwater invertebrates acute (310) and reproduction NOAEC (390-690), estuarine fish acute (32) and reproduction NOAEC (56-99), and estuarine invertebrates acute (880) and reproduction NOAEC (>3400->6000).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 61 ppm and whole fish of 43 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm but more than the avian reproductive NOAEL of 25 ppm.

Wildlife utilization of citrus groves ranges from low to a moderate and high degree for a broad diversity of avian and mammalian species (Gusey and Maturgo 1973). Mammals reported to feed moderately in citrus groves, include raccoons and deer. Mourning doves, pheasants and 13 species of birds are listed as nesting in citrus groves. During the California orange field study, between 188 to 561 birds were observed on plots in orange groves. While it is unlikely that deer might be adversely affected, because of its large size, many of the other species could be affected by consumption of food items (such as seeds, insects and vegetation) found in chlorpyrifos-treated citrus fields. Wildlife carcasses with chlorpyrifos residues found in the field study included a mockingbird, ground squirrel, pocket gopher and a western rattlesnake.

(vi) Fruit and Nut Orchard Applications (dormant, foliar, trunk &/or soil floor)

According to BEAD, pome orchards represent about 3 percent of the total poundage, and stone fruits, almonds, and other nuts are all less than 1 percent. Apples are the highest use of chlorpyrifos in this category with about 44 to 53 percent of the acreage treated or about 250,000 to 300,000 acres. Apple uses total about 77 percent in decreasing order in the following states: Washington, Minnesota, New York, California, Vermont, and North Carolina. Pecans are the next highest use of chlorpyrifos in this category with approximately 140,000 to 170,000 acres treated in Texas, Georgia, Louisiana, and Oklahoma totaling about 85 percent. Use on other nut orchards include: walnuts in California (about 30 to 39 percent of crop), almonds in California (about 20 to 29 percent), and other nuts: chestnuts, filberts (hazelnuts) and macadamia nuts (about 6 to 9 percent). Other crops included in this category as fruits are cranberries and grapes. Figs are limited to use in California and macadamia nuts are limited to use in Hawaii.

Directions for chlorpyrifos use on registered labels are limited to spray treatments for fruit and nut trees. Four basic spray treatments are used for fruit and nut trees: 1 application on dormant trees; 1 to 3 trunk (bark) applications (8 applications on macadamia nuts); 2 to 8 foliar applications; and 1 to 5 soil, spray broadcast treatments to orchard floors.

Dormant Tree Uses: BEAD's Quantitative Usage Analysis does not differentiate between the poundage of chlorpyrifos used as dormant sprays on trees, foliar and orchard floor treatments.

Directions for chlorpyrifos use on registered labels are for a single, dormant treatment sprayed

airblast by ground equipment at 0.5 lb ai/100 gallon at 200-600 finished spray/A (i.e., 2-3 lbs ai.A) on apples, nectarines, peaches, pears, plums and prunes. A single, dormant application on almonds and walnuts sprayed at 2 lb ai/A or 2 lb ai/100 gallons. Trunk (bark) applications to be sprayed at 3 lbs ai/100 gallons using ground equipment on almonds (2 applications at a minimum retreatment interval of 60 days), sweet cherries (3 applications at minimum interval of 14 days), and one application to nectarines and peaches. Non-bearing, preplant peaches may be dip treated at 3 lbs/100 gallons. Dipping and bark applications can be assessed for wildlife risks, but spraying to runoff is difficult to quantify for aquatic exposures. The following table shows the risk quotients for dormant uses on fruit trees at 3 lbs ai./A.

Risk Quotients for Apples, Nectarines, Peaches, Pears, Plums, and Prunes (Dormant Ground Airblast Spray; 3 lbs ai/A; 1 Application) (Terrestrial EEC's Based on Nomograph; Aquatic EEC's Based on GENEEC Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	405 - 720 ppm	102 ppm 147 ppm 647 ppm	4.0 - 7.1 2.8 - 4.9 0.63 - 1.1
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	45 - 405 ppm	102 ppm 147 ppm 647 ppm	0.44 - 4.0 0.31 - 2.8 0.070- 0.63
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	45 - 405 ppm	462 ppm 647 ppm 3233 ppm	0.097- 0.88 0.070- 0.63 0.014- 0.13
Mammalian Subacute Dietary LC ₅₀	405 - 720 ppm	1330 ppm	0.30 - 0.54
Mammalian Reproduction NOAEL	405 - 720 ppm	10 ppm	40 - 72
Avian Subacute Dietary LC ₅₀	405 - 720 ppm	136 ppm	3.0 - 5.3
Avian Reproduction NOAEL	405 - 720 ppm	25 ppm	16 - 29
Freshwater Fish Acute LC ₅₀	15.4 ppb	1.8 ppb	8.6
Fish Reproduction NOAEC	7.6 -13.7 ppb	0.57 ppb	13 - 24
Aquatic Invertebrate Acute LC ₅₀	15.4 ppb	0.10 ppb	150
Freshwater Invert. Reproduction NOAEC	7.6 -13.7 ppb	0.04 ppb	190 - 340
Estuarine Fish Acute LC ₅₀	15.4 ppb	0.96 ppb	16
Estuarine Fish Reproduction NOAEC	7.6 -13.7 ppb	0.28 ppb	27 - 49
Estuarine Invertebrate Acute LC ₅₀	15.4 ppb	0.035 ppb	440
Estuarine Invert. Reproduction NOAEC	7.6 -13.7 ppb	< 0.0046 ppb	> 1700 > 3000

Risk Summary for Maximum Dormant Tree Uses: Chlorpyrifos sprayed airblast on dormant fruit and nut trees at 3 lbs ai/A yields risk quotients which exceed the level of concern for most non-target aquatic and terrestrial animals. Risk quotients are mammalian acute (0.014-7.1), subacute (0.30-0.54) and reproduction NOAEL (40-72), avian subacute (3.0-5.3) and reproduction NOAEL (16-29), freshwater fish acute (8.6) and reproduction NOAEC (13-24),

aquatic invertebrate acute (150) and reproduction NOAEC (190-340), estuarine fish acute (16) and reproduction NOAEC (27-49), estuarine invertebrate acute (440) and reproduction NOAEC (>1700->3000).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 30 ppm and whole fish of 21 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm but more than the avian reproductive NOAEL of 25 ppm.

Aquatic EECs calculated with the GENEEC Model for dormant uses are probably slightly high and overestimate the aquatic EECs. While spray drift from airblast would be about 5 percent, runoff is likely to be reduced, because these orchards usually have grass or a ground cover around the trees. The ground cover reduces soil erosion and generally would yield lower aquatic risks via runoff than those modelled for citrus, which have usually have bare ground.

Chlorpyrifos (level of detection 40 ng/L) was measured as trace to 42 ng/L in the San Joaquin River at Vernalis, California daily between February 9 and 18, 1993 are attributed to dormant spray use of about 17,500 kg of chlorpyrifos on fruit trees in the San Joaquin Valley (Kuivila and Foe, 1995).

Summary of Risks for Dormant Walnut Use: Risk quotients for dormant airblast treatments of almond and walnut trees sprayed at 2 lbs ai/A are about two-thirds of the above RQ values.

Fruit and Nut Foliar Uses: Foliar chlorpyrifos applications are sprayed with ground or aerial equipment 5 times at 2 lbs ai/A on pecans, 3 times at 2 lbs ai/A or 2 lbs/100 gallons to almonds, filberts and walnuts; 8 times at 1.5 lbs ai/A or 1.5 lb ai/100 gal. to apples (21 day interval between final two applications) and to sour cherries). Foliar applications on grapes at 1 lb ai/A with ground equipment at pre-bloom in Michigan and Missouri and with ground or aerial equipment on non-bearing vines in Idaho, Oregon, and Washington. The following two tables show the minimum and maximum risk quotients for nut and fruit tree foliar treatments.

Risk Quotients for Almonds and Filberts (Foliar Aerial Spray Treatment; 2 lbs ai/A; 3 Applications; 7-Day Interval) (Terrestrial EEC's Based on FATE Model; Aquatic EEC's Based on GENEEC Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	236 - 420 ppm	102 ppm 147 ppm 647 ppm	2.3 - 4.1 1.6 - 2.9 0.36 - 0.65
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	26 - 236 ppm	102 ppm 147 ppm 647 ppm	0.25 - 2.3 0.18 - 1.6 0.040 - 0.36

Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	26 - 236 ppm	462 ppm 647 ppm 3233 ppm	0.056- 0.51 0.040- 0.36 0.008- 0.073
Mammalian Subacute Dietary LC ₅₀	236 - 420 ppm	1330 ppm	0.18 - 0.32
Mammalian Reproduction NOAEL	236 - 420 ppm	10 ppm	24 - 42
Avian Subacute Dietary LC ₅₀	236 - 420 ppm	136 ppm	1.7 - 3.1
Avian Reproduction NOAEL	236 - 420 ppm	25 ppm	9.4 - 17
Freshwater Fish Acute LC ₅₀	33 ppb	1.8 ppb	18
Fish Reproduction NOAEC	16 - 29.4 ppb	0.57 ppb	28 - 52
Aquatic Invertebrate Acute LC ₅₀	33 ppb	0.10 ppb	330
Freshwater Invert. Reproduction NOAEC	16 - 29.4 ppb	0.04 ppb	400 - 740
Estuarine Fish Acute LC ₅₀	33 ppb	0.96 ppb	34
Estuarine Fish Reproduction NOAEC	16 - 29.4 ppb	0.28 ppb	57 - 110
Estuarine Invertebrate Acute LC ₅₀	33 ppb	0.035 ppb	940
Estuarine Invert. Reproduction NOAEC	16 - 29.4 ppb	< 0.0046 ppb	> 3500 > 6400

Risk Summary for Maximum Almond and Filbert Foliar Uses: Chlorpyrifos sprayed by airblast on almond trees three times at 2 lbs ai/A yield risk quotients which exceed the levels of concern for most non-target aquatic and terrestrial animals. Risk quotients are mammalian acute (0.008-4.1), subacute (0.18-0.32) and reproduction NOAEL (24-42), avian subacute (1.7-3.1) and reproduction NOAEL (9.4-17), freshwater fish acute (18) and reproduction NOAEC (28-52), aquatic invertebrate acute (330) and reproduction NOAEC (400-740), estuarine fish acute (34) and reproduction NOAEC (107-200), estuarine invertebrate acute (940) and reproduction NOAEC (>3500->6400).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 62 ppm and whole fish of 44 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm but more than the avian reproductive NOAEL of 25 ppm.

Risk Quotients for Apples and Sour Cherries (Foliar Aerial Spray Treatment; 1.5 lbs ai/A; 8 Applications; 7-Day Interval) (Terrestrial EEC's Based on FATE Model; Aquatic EEC's Based on GENEEC Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	403 - 717 ppm	102 ppm 147 ppm 647 ppm	4.0 - 7.0 2.7 - 4.9 0.62 - 1.1
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	45 - 403 ppm	102 ppm 147 ppm 647 ppm	0.44 - 4.0 0.31 - 2.7 0.070- 0.62

Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	45 - 403 ppm	462 ppm 647 ppm 3233 ppm	0.097- 0.87 0.070- 0.62 0.014- 0.12
Mammalian Subacute Dietary LC ₅₀	403 - 717 ppm	1330 ppm	0.30 - 0.54
Mammalian Reproduction NOAEL	403 - 717 ppm	10 ppm	40 - 71
Avian Subacute Dietary LC ₅₀	403 - 717 ppm	136 ppm	3.0 - 5.3
Avian Reproduction NOAEL	403 - 717 ppm	25 ppm	16 - 29
Freshwater Fish Acute LC ₅₀	61.8 ppb	1.8 ppb	34
Fish Reproduction NOAEC	30 - 55 ppb	0.57 ppb	53 - 96
Aquatic Invertebrate Acute LC ₅₀	61.8 ppb	0.10 ppb	620
Freshwater Invert. Reproduction NOAEC	30 - 55 ppb	0.04 ppb	750 - 1400
Estuarine Fish Acute LC ₅₀	61.8 ppb	0.96 ppb	64
Estuarine Fish Reproduction NOAEC	30 - 55 ppb	0.28 ppb	107 - 200
Estuarine Invertebrate Acute LC ₅₀	61.8 ppb	0.035 ppb	1800
Estuarine Invert. Reproduction NOAEC	30 - 55 ppb	< 0.0046 ppb	> 6500 >12000

Risk Summary for Maximum Fruit Tree Foliar Uses: Eight aerial spray treatments with chlorpyrifos to pome fruit trees at 1.5 lbs ai/A yield risk quotients which exceed the levels of concern for most non-target aquatic and terrestrial animals. Risk quotients are mammalian acute (0.014-7.0), subacute dietary (0.3-0.54) and reproduction NOAEL (40-71), avian subacute dietary (3.0-5.3) and reproduction NOAEL (16-29), fresh-water fish acute (34) and reproduction NOAEC (53-96), aquatic invertebrate acute (620) and reproduction NOAEC (750-1400), estuarine fish acute (64) and reproduction NOAEC (107-200), estuarine invertebrate acute (1800) and reproduction NOAEC (>6500->12000).

Food chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 117 ppm and whole fish of 82 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm but more than the avian reproductive NOAEL of 25 ppm.

Trunk Applications to Macadamia Nut Uses: Tree trunks of macadamia nuts are sprayed with ground equipment 8 times at 1 lb ai/A with a minimum retreatment interval of 30 days (use limited to Hawaii).

Risk Summary for Maximum Foliar Macadamia Nut Uses: Risk quotients for macadamia nut trees sprayed 8 times at 1 lb ai/A are less than the above RQ values for the 8 foliar application to sour cherries.

Cranberry Uses: Applications to cranberries are foliar sprays applied twice per season at 1.5 lbs ai/A. Cranberries may not be treated when the bogs are flooded. The following table shows the

risk quotients for cranberry use.

Risk Quotients for Cranberries (Foliar Aerial Spray; 1.5 lbs ai/A; 2 Applications; 7-Day Interval) (Terrestrial EEC's Based on FATE Model; Aquatic EEC's Based on GENEEC Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	303 - 540 ppm	102 ppm 147 ppm 647 ppm	3.0 - 5.3 2.1 - 3.7 0.47 - 0.83
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	34 - 303 ppm	102 ppm 147 ppm 647 ppm	0.33 - 3.0 0.23 - 2.1 0.053- 0.47
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	34 - 303 ppm	462 ppm 647 ppm 3233 ppm	0.074- 0.66 0.053- 0.47 0.011- 0.094
Mammalian Subacute Dietary LC ₅₀	303 - 540 ppm	1330 ppm	0.23 - 0.41
Mammalian Reproduction NOAEL	303 - 540 ppm	10 ppm	30 - 54
Avian Subacute Dietary LC ₅₀	303 - 540 ppm	136 ppm	2.2 - 4.0
Avian Reproduction NOAEL	303 - 540 ppm	25 ppm	12 - 22
Freshwater Fish Acute LC ₅₀	16.7 ppb	1.8 ppb	9.3
Fish Reproduction NOAEC	8.1 - 15 ppb	0.57 ppb	14 - 26
Aquatic Invertebrate Acute LC ₅₀	16.7 ppb	0.10 ppb	170
Freshwater Invert. Reproduction NOAEC	8.1 - 15 ppb	0.04 ppb	200 - 380
Estuarine Fish Acute LC ₅₀	16.7 ppb	0.96 ppb	17
Estuarine Fish Reproduction NOAEC	8.1 - 15 ppb	0.28 ppb	29 - 54
Estuarine Invertebrate Acute LC ₅₀	16.7 ppb	0.035 ppb	480
Estuarine Invert. Reproduction NOAEC	8.1 - 15 ppb	< 0.0046 ppb	> 1800 > 3300

Risk Summary for Cranberry Use: Two aerial spray treatments with chlorpyrifos to cranberries at 1.5 lbs ai/A yield risk quotients which exceed the levels of concern for most non-target aquatic and terrestrial animals. Risk quotients are mammalian acute (0.011-5.3), subacute dietary (0.23-0.41) and reproduction NOAEL (30-54), avian subacute dietary (2.2-4.0) and reproduction NOAEL (12-22), freshwater fish acute (9.3) and reproduction NOAEC (14-26), aquatic invertebrate acute (170) and reproduction NOAEC (200-380), estuarine fish acute (17) and reproduction NOAEC (29-54), estuarine invertebrate acute (480) and reproduction NOAEC (>1800->3300).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 32 ppm and whole fish of 22 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm but more than the avian

reproductive NOAEL of 25 ppm.

Aerial applications on cranberries are a particular concern, because spray drift to adjacent freshwater and estuarine areas poses very high risks to sensitive aquatic species. Concern also exists for the flooding and drainage of chlorpyrifos-treated cranberry bogs into freshwater and estuarine areas. Pait *et al.* 1992 (NOAA) reported chlorpyrifos residues in near-shore sediments of Buzzards Bay, Massachusetts, which was stated as probably due to its use in cranberry farming (Gil, 1990). Public comments from the Cape Alliance for Pesticide Education indicated that USGS data has shown that chlorpyrifos is prevalent in streams and wells; that the Commonwealth of Massachusetts has found chlorpyrifos during random sampling of surface waters adjacent to cranberry bogs; and that chlorpyrifos has been found to cause documented fish kills in waters downstream from cranberry bogs. Supporting data was not provided by the Cape Alliance for Pesticide Education.

Grape Uses: Grapes applications may be soil sprayed at 2.25 lbs ai/100 gallons (2 quarts finished spray per 15 sq. ft.), foliar at 1.125 lb ai/100 gallons (2 quarts finished spray per 15 sq. ft.), a prebloom, foliar, ground application at 1 lb ai/A (use limited to MI and MO), and non-bearing, foliar spray by ground or aerial equipment at 1 lb ai/A (use limited to Idaho, Oregon, and Washington). The following table shows the risk quotients for foliar grape uses.

Risk Quotients for Grapes (Foliar Aerial Spray; 1 lb ai/A; 1 Application) (Terrestrial EEC's Based on Nomograph; Aquatic EEC's Based on GENEEC Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	135 - 240 ppm	102 ppm 147 ppm 647 ppm	1.3 - 2.4 0.92 - 1.6 0.21 - 0.37
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	15 - 135 ppm	102 ppm 147 ppm 647 ppm	0.15 - 1.3 0.10 - 0.92 0.023- 0.21
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	15 - 135 ppm	462 ppm 647 ppm 3233 ppm	0.032- 0.29 0.023- 0.21 0.005- 0.042
Mammalian Subacute Dietary LC ₅₀	135 - 240 ppm	1330 ppm	0.10 - 0.18
Mammalian Reproduction NOAEL	135 - 240 ppm	10 ppm	14 - 24
Avian Subacute Dietary LC ₅₀	135 - 240 ppm	136 ppm	0.99- 1.8
Avian Reproduction NOAEL	135 - 240 ppm	25 ppm	5.4 - 9.6
Freshwater Fish Acute LC ₅₀	5.1 ppb	1.8 ppb	2.8
Fish Reproduction NOAEC	2.5 - 4.6 ppb	0.57 ppb	4.4 - 8.1
Aquatic Invertebrate Acute LC ₅₀	5.1 ppb	0.10 ppb	51
Freshwater Invert. Reproduction NOAEC	2.5 - 4.6 ppb	0.04 ppb	62 - 120
Estuarine Fish Acute LC ₅₀	5.1 ppb	0.96 ppb	5.3

Estuarine Fish Reproduction NOAEC	2.5 - 4.6 ppb	0.28 ppb	8.9 - 16
Estuarine Invertebrate Acute LC ₅₀	5.1 ppb	0.035 ppb	150
Estuarine Invert. Reproduction NOAEC	2.5 - 4.6 ppb	< 0.0046 ppb	> 540 > 1000

Risk Summary for Grape Uses: Chlorpyrifos aerially sprayed onto grapes at 1 lb ai/A yields risk quotients which exceed the levels of concern for most non-target aquatic and terrestrial animals. Risk quotients are mammalian acute (0.005-2.4), subacute (0.10-0.18) and reproduction NOAEL (14-24), avian subacute (0.99-1.8) and reproduction NOAEL (5.4-9.6), freshwater fish acute (2.8) and reproduction NOAEC (4.4-8.1), aquatic invertebrate acute (51) and reproduction NOAEC (62-120), estuarine fish acute (5.3) and reproduction NOAEC (8.9-16), estuarine invertebrate acute (150) and reproduction NOAEC (>540->1000).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 9.8 ppm and whole fish of 6.8 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm and less than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm and less than the avian reproductive NOAEL of 25 ppm.

Fruit and Nut Orchard Floor Uses: Soil broadcast treatments on grove floor are sprayed by ground equipment on almonds twice at 4 lbs ai/A, on pecans 5 times at 2 lbs ai/A, on dormant figs once at 2 lbs ai/A with 3-inch soil incorporation (use limited to California), on soil surface on a 15-square foot area around the base of each grape vine once at 2.25 lb/100 gal. (2 quarts of finished spray/ 15 sq. ft.) not letting spray contact fruit or foliage (use limited to east of Rocky Mountains) or sprayed twice at 1.125 lb ai/100 gal. (use limited to Georgia and Tennessee). The two following tables show risk quotients for almond and pecans orchard floor uses.

Risk Quotients for Almond Orchard Floor (Soil Broadcast Ground Spray Treatment; 4 lbs ai/A; 2 Applications; 7-Day Interval) (Terrestrial EEC's Based on FATE Model; Aquatic EEC's Based on GENEEC Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	810 - 1440 ppm	102 ppm 147 ppm 647 ppm	7.9 - 14 5.5 - 9.8 1.3 - 2.2
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	90 - 810 ppm	102 ppm 147 ppm 647 ppm	0.88 - 7.9 0.61 - 5.5 0.14 - 1.3
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	90 - 810 ppm	462 ppm 647 ppm 3233 ppm	0.19 - 1.8 0.14 - 1.3 0.028- 0.25
Mammalian Subacute Dietary LC ₅₀	810 - 1440 ppm	1330 ppm	0.61 - 1.1
Mammalian Reproduction NOAEL	810 - 1440 ppm	10 ppm	81 - 140
Avian Subacute Dietary LC ₅₀	810 - 1440 ppm	136 ppm	6.0 - 11

Avian Reproduction NOAEL	810 - 1440 ppm	25 ppm	32 - 58
Freshwater Fish Acute LC ₅₀	30 ppb	1.8 ppb	17
Fish Reproduction NOAEC	15 - 26 ppb	0.57 ppb	26 - 46
Aquatic Invertebrate Acute LC ₅₀	30 ppb	0.10 ppb	300
Freshwater Invert. Reproduction NOAEC	15 - 26 ppb	0.04 ppb	375 - 650
Estuarine Fish Acute LC ₅₀	30 ppb	0.96 ppb	31
Estuarine Fish Reproduction NOAEC	15 - 26 ppb	0.28 ppb	54 - 93
Estuarine Invertebrate Acute LC ₅₀	30 ppb	0.035 ppb	860
Estuarine Invert. Reproduction NOAEC	15 - 26 ppb	< 0.0046 ppb	> 3300 - > 5700

Risk Summary for Maximum Almond Orchard Floor Use: Chlorpyrifos sprayed twice to soil on almond orchard floor at 4 lbs ai/A yield risk quotients which exceed the levels of concern for most non-target aquatic and terrestrial animals. Risk quotients are mammalian acute (0.028-0.25), subacute (0.61-1.1) and reproduction NOAEL (81-140), avian subacute (6.0-11) and reproduction NOAEL (32-58), freshwater fish acute (17) and reproduction NOAEC (26-46), aquatic invertebrate acute (300) and reproduction NOAEC (375-650), estuarine fish acute (31) and reproduction NOAEC (54-93), estuarine invertebrate acute (860) and reproduction NOAEC (>3300->5700).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 59 ppm and whole fish of 41 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm but more than the avian reproductive NOAEL of 25 ppm.

Risk Quotients for Pecan Orchard Floor (Soil Broadcast Ground Spray Treatment; 2 lbs ai/A; 5 Applications; 7-Day Interval) (Terrestrial EEC's Based on FATE Model; Aquatic EEC's Based on GENEEC Model)			
Species	Exposure	Toxicity	Risk Quotient
Mammalian Herbivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	523 - 930 ppm	102 ppm 147 ppm 647 ppm	5.1 - 9.1 3.6 - 6.3 0.81 - 1.4
Mammalian Insectivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	58 - 523 ppm	102 ppm 147 ppm 647 ppm	0.57 - 5.1 0.39 - 3.6 0.09 - 0.81
Mammalian Granivores LD ₅₀ (15 grams body wt.) (35 grams body wt.) (1000 grams body wt.)	58 - 532 ppm	462 ppm 647 ppm 3233 ppm	0.13 - 1.1 0.9 - 0.81 0.018 - 0.16
Mammalian Subacute Dietary LC ₅₀	58 - 930 ppm	1330 ppm	0.044 - 0.7
Mammalian Reproduction NOAEL	58 - 930 ppm	10 ppm	58 - 93
Avian Subacute Dietary LC ₅₀	58 - 930 ppm	136 ppm	0.43 - 6.8

Avian Reproduction NOAEL	58 - 930 ppm	25 ppm	2.3 - 37
Freshwater Fish Acute LC ₅₀	35.7 ppb	1.8 ppb	20
Fish Reproduction NOAEC	16.8 - 30.9 ppb	0.57 ppb	29 - 54
Aquatic Invertebrate Acute LC ₅₀	35.7 ppb	0.10 ppb	360
Freshwater Invert. Reproduction NOAEC	16.8 - 30.9 ppb	0.04 ppb	420 - 770
Estuarine Fish Acute LC ₅₀	35.7 ppb	0.96 ppb	37
Estuarine Fish Reproduction NOAEC	16.8 - 30.9 ppb	0.28 ppb	60 - 110
Estuarine Invertebrate Acute LC ₅₀	35.7 ppb	0.035 ppb	1000
Estuarine Invert. Reproduction NOAEC	16.8 - 30.9 ppb	< 0.0046 ppb	> 3700 > 7700

Risk Summary for Maximum Pecan Orchard Floor Use: Chlorpyrifos sprayed five times to soil on a pecan orchard floor at 2 lbs ai/A yield risk quotients which exceed the levels of concern for most non-target aquatic and terrestrial animals. Risk quotients are mammalian acute (0.018-9.1), subacute (0.044-0.7) and reproduction NOAEL (58-93), avian subacute (0.43-6.8) and reproduction NOAEL (2.3-37), freshwater fish acute (20) and reproduction NOAEC (29-54), aquatic invertebrate acute (360) and reproduction NOAEC (420-770), estuarine fish acute (37) and reproduction NOAEC (60-110), estuarine invertebrate acute (1000) and reproduction NOAEC (>3700->7700).

Food Chain Effects: Piscivorous mammals are exposed to estimated residues in the fish viscera of 66 ppm and whole fish of 46 ppm. These levels are less than the mammalian subacute LC₅₀ value of 1330 ppm but more than the mammalian reproductive NOAEL of 10 ppm. These residue levels in fish are less than the avian subacute LC₅₀ value of 136 ppm but more than the avian reproductive NOAEL of 25 ppm.